REPORT

OF THE PROCEEDINGS OF THE

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convened by

The Committee of Vice-Chancellors and Principals

and held in

THE WILLIAM BEVERIDGE HALL
UNIVERSITY OF LONDON SENATE HOUSE

on

Friday and Saturday December 17th and 18th 1954

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FIRST SESSION

FRIDAY AFTERNOON, 17TH DECEMBER

THE SUPPLY OF TEACHERS FOR MATHEMATICS AND SCIENCE

Chairman Sir CHARLES MORRIS, M.A., LL.D., D.Litt., Vice-Chancellor University of Leeds, and Chairman, Committee of Vice-Chancellors and Principals.

The following notes were circulated prior to the conference

A. Notes for Address by Dr E. J F JAMES.

Introduction. Urgency of situation and difficulty of proposing solutions.

Problem one of quality as well as quantity Effect of quality on breadth of scientific education.

Causes of shortage. Part of general shortage of skilled manpower But why special aversion to teaching on part of science students? A field for investigation here.

- (a) Financial reasons. Obviously partly responsible, yet not the whole story
- (b) Appeal of research. In my view the most powerful counter-attraction.
- (c) Misconceptions about the life of a teacher

It is in the light of these factors that we must suggest strong measures for attracting young scientists.

- (1) Salary position. Limitation of the Burnham arrangements.
- (2) Self-denying policy on the part of industry Are all scientists in industry being suitably employed?
- (3) Part to be played by universities.
  - (a) Propaganda and advice in university science departments by practising schoolmasters and by university teachers.
  - (b) Provision of science courses for those entering with arts qualifications. How far is this possible? Difficulties and limitations.
- (4) Measures within the schools (a) by propaganda, (b) by increasing the total number of scientists by diversion of boys from arts to science—difficulties and limitations of this approach, (c) by tackling the problem of the early leaver

(5) Other measures. (*a*) Some scientists are deterred by supposed necessity for diploma in education, (*b*) teaching should be a recognised alternative to national service. Taking these two together we might at any rate secure three years of a young scientist's life for teaching, and many would be permanently attracted.

Conclusion.

B. Summary of Address by Professor R. E. PEIERLS.

The long-term problem requires in my view an increase in the total number of scientists and mathematicians trained in the universities since the demand from industry government service and other employers is not likely to diminish, though the question of their most efficient use in industry which Dr James raises, should be seriously considered On a short term basis the problem arises of dividing the available graduates in the most efficient way between teaching and other employment during the next few years more must be diverted to teaching if the shortage of good teachers is not to lead actually to a reduction in the number of suitable candidates entering on science courses at the universities. At the same time one should think of ways of training more potential scientists by a different use of the existing teaching staff

Possible short-term measures therefore include

(1) Students entering the universities without sixth-form preparation in science or mathematics, or with a reduced amount of such training. This involves for the universities problems of staff and of the organization of courses. It also is connected with the question of educational grants for such students.

(2) The exchange of sixth-form pupils between smaller schools or between these and technical colleges, either as a complete exchange or for certain subjects only

(3) An increased use of the "pass" degree course to provide graduates of a sufficiently high intellectual quality but without necessarily having pursued their subject to the same advanced level as honours students. Here the main difficulty appears to be the present low prestige of the pass degree.

(4) Measures to facilitate the transfer to teaching of scientists and mathematicians now in other employment, who discover later in life an interest in teaching. This would have to include an arrangement by which they could be given credit for their past experience, which will benefit their teaching, and a recruitment campaign amongst such people.

On the long-term problem of increasing the total supply of scientists one must start from the question whether there now exist potential scientists or mathematicians who either do not enter for university courses in these subjects, or who apply for admission to universities but are not accepted or fail in their course. I suspect that there still are schools which persuade their most promising pupils to go in for classics courses and, if this is correct, some propaganda for science might help. It is also likely that some potentially good applicants do not now qualify for entry to the university because their school was not able to provide an adequate science course. This would in part be remedied by the short-term measures previously discussed. In addition it is important to review the present selection methods to make sure that no good candidates are missed, even if their G.C.E. marks are not outstanding.

Amongst long-term measures designed to make the teaching profession more attractive to scientists one should consider an arrangement by which teachers who want to keep in touch with modern developments in their subject could at certain intervals have a term's leave of absence, to be spent at a university or similar institution, so that they could take part in modern research activities.

All these remarks are based on the assumption that the number of graduate scientists and mathematicians can be increased to the required level. If this should prove impossible one might have to make some of the proposed short-term measures more permanent. In particular it might be argued that the existing manpower would be used more effectively if the majority of students entered the universities at a lower level (the old "intermediate" course) where the same member of staff would teach a much larger number of students than is possible in the school. This, however, is so contrary to the present trend that it will not be seriously considered as a permanent solution unless all other measures fail.

The CHAIRMAN: It would be very difficult for anybody, and certainly very difficult for me, to open this first session of the conference this year without saying what a very great pleasure it is to us to have the hospitality of the University of London to enable us to hold the conference under such excellent conditions. In general, I think that all of us in the universities feel at the present time an immense debt of gratitude to the University of London for the hospitality which it gives us. We shall have an opportunity in due course of expressing our gratitude, but it is rather difficult not to mention it at the beginning of the conference.

The business of the Chairman at the first session is to get the conference going with the least possible delay The conference is usually extremely good at this. Unlike most conferences, it does not allow long periods of embarrassed silence after the opening speakers, and I am sure that it will live up to its reputation in this respect.

We are today extraordinarily fortunate in our opening speakers. We are delighted that Professor Peierls, who we know has given much energy to collecting statistics about the availability of mathematics students, has come to open the discussion, and we are particularly delighted to be able to welcome Dr Eric James, from the Manchester Grammar School, and a member of the University Grants Committee, as the first speaker on this very important subject.

I suppose that there are few subjects on which we are so firmly agreed that the situation is very serious and very important to the universities. While you were filing into the room, from the discussion which went on behind my back between the two opening speakers I gathered that they had both quite ultroneously been looking forward for some years to crossing swords and differing from one another about a number of points which they have in mind, but I gathered also that they did not anticipate that they were going to find it very easy to differ from one another on this afternoon s topic. In any case, we are very grateful to them for coming to open the discussion on a matter which is of tremendous importance to us.

I now ask Dr James, without further ado to speak to us on the subject of "The supply of teachers for mathematics and science."

E. J F James M.A., D.Phil. High Master Manchester Grammar School, and Chairman, Headmasters' Conference The topic you have mentioned, Sir Charles as the opening one this afternoon can, I suppose, be considered as very appropriate for the first item on the agenda of this conference, and, on the other hand as a very unfortunate one. It is appropriate because there are, I suppose, few other questions in English higher education that rival it in urgency and it may well be considered as very unfortunate because it puts to you right at the start of your proceedings a problem to which I think there is simply no straightforward or easy solution.

It may well be asked, indeed whether we are much further forward in this matter than we were some eight or nine years ago when some of us were calling attention to it. In one way I think we are. There is now a much wider realisation that in fact there *is* a problem. The shortage of science teachers

is the theme of an increasing number almost a monotonous number of speeches and reports. The National Advisory Council on Scientific Policy the Science Masters Association, the F.B.I., the Advisory Council on the Supply of Teachers have all considered it but, thoughtful and interesting as some of those reports have been, it would be idle to suggest that any real solutions have been proposed And I must confess straight away that I am able to do very little that has not been done before. All I can do is to suggest a number of lines of approach which, taken together may do something to save a desperate situation.

Now in the first place, it is obviously unnecessary for me before this audience to say more than a word or two on the magnitude of the problem. There are some fortunate schools —and mine is one of them—that are happy in their science staffs although if anyone in this audience knows of a good physics master I would be pleased to see him afterwards. But the great majority of headmasters and headmistresses know that if they lose a teacher of science or mathematics he will be replaced by someone of lower calibre, if indeed he is replaced at all. We know that much of the advanced work in our schools on which the universities depend is kept doing by men and women of 45 and over In a country and an age in which our future survival depends on scientific man power the supply of such manpower is in danger of diminishing at its source.

We are making a very great effort, a laudable effort, to expand technology at the university level, whether we expand it in one kind of institution or another· but of what use is such expansion unless students adequate in quality and quantity are to come forward to fill the places that we create? We are entering on a new technological revolution that will be dominated by new techniques and new sources of power What will be the position of this country if the men who should be the architects of that revolution are growing up without adequate science teaching? I am not thinking primarily of the absolutely first-rate person who can perhaps survive bad teaching, as they have often survived it in the past; I am thinking rather of those slightly less good people who without adequate grounding, cannot be expected to face university courses themselves crowded with new knowledge.

We demand, and we rightly demand that our scientists should be broad and humane men. I would emphasize that the best hope of producing such scientists is for them to be taught science by good minds. It is the third-rate scientist who is most likely to produce pupils whose horizons are limited by three Advanced level subjects. In short, I say in all seriousness— I know that everyone would

that it is almost impossible to exaggerate the evils that may result if the level of science teaching continues to fall, evils for our economic future and cultural standards and for the progress of science itself

Before we can cure a disease, we have obviously to diagnose its causes To some extent, of course, the shortage of science teachers is but one aspect of a much larger and much more fundamental problem that has not been considered yet as much as it should be Our kind of society makes altogether unprecedented demands on our resources of natural ability of all kinds, not only scientific ability It may well be that very complex technological communities will gradually lose their impetus, that we shall reach a limit, a state in which we can envisage but never be able to explore whole new fields of knowledge and progress simply because of the shortage of people with the intelligence and training required. This is no short term problem with which we are faced, it is a chronic condition.

Quite apart from that very general question that I have not time to explore this afternoon we do know that there seem to be special reasons why young men and women of scientific ability do not want to teach. What are those reasons? And here I think that our inquiries and our committees have failed. We should, in fact, have inquired much more carefully than we have done into these interesting and vital problems of motive What makes someone want to teach? What makes someone not want to teach? The obvious answer of course is an economic one. Young men do not want to teach, we are told, because they can get more money in industry That is undoubtedly true and teachers salaries are without doubt a very powerful factor but that is not I am quite sure the whole story and we shall go badly wrong if we think it is.

A second reason is the appeal of research, and here I believe is a factor of immense power When my friend Dr Birley spoke to the British Association in 1953 he made the interesting suggestion that the reluctance of scientists to teach might be due to a lack of faith in science. That is a very interesting and very arguable point of view but actually I believe that our problem, at any rate in one aspect arises in great measure simply because the young have such a burning faith in science. It is a faith symbolised by this magic word "research." Of all fields of knowledge science is that in which it is easiest to acquire the techniques of discovering new truths, and the young men in our sixth forms, rightly and laudably have an idea of themselves as pushing back the frontiers of knowledge in four or five years after they leave us, and it is perhaps the most interesting and the most significant feature of the intellectual climate of our time that

so many of them will be able to do so. You have not got to be frightfully clever to discover something in science—I mean compared with a field like philosophy.

The third factor that I think produces our present crisis arises from ignorance and prejudice. I had the privilege of speaking some time ago to the chemistry students at two of our greatest universities about teaching as a career. I found among them a belief that the material position and prospects of schoolmasters were worse even than they are. I found that we had over played the sense of vocation—that mystic word that is used to encourage people to do something at a salary less than we ought to pay them. They felt that unless a man could look forward to a life dominated entirely by the patter of tiny feet, like Mr Chips, he was unfitted to be a teacher. I found that they had been discouraged from teaching by teachers themselves often disillusioned by service under the less enlightened local authorities and by attacks upon the grammar schools.

It is in the light of these factors that we have got to try to suggest actual measures to attract young scientists of good quality as teachers.

I want first to say something about the economic position. The Burnham Committee has done fine work, and one must be full of admiration as one contemplates its labours and its successes on behalf of the great majority of teachers. But in the nature of things that body works within certain limitations and on the basis of certain assumptions—the assumption that all teachers are simply teachers unless they happen to teach in technical schools or universities: the impression conveyed to the minds of many teachers in grammar schools that all teachers are equal but some are more equal than others. It is no part of the Committee's task to question those basic assumptions, that could only be done from outside. There can be no doubt, rightly or wrongly—and it is the facts we are dealing with—that the academically qualified teacher in the grammar school feels that salary policy in the last few years has been unjust to him, that it has touched not only his pocket but also that mysterious entity his prestige. He may over-estimate the degree of injustice, but it is this feeling communicated, as unfortunately it has been, to those who might enter the profession that is the determining factor. It is of little use telling him that a good local authority, by generous use of the pool, can pay him a pretty adequate salary. The young graduate must not feel that his future depends on the good will and enlightenment of a particular education authority. He requires a firmer prospect. If in fact the Burnham Committee cannot, through no fault of its own perhaps, devise adequate scales for grammar-school teachers,

then we must look beyond it, and I confess that I see no alternative to a Royal Commission or something of that sort on the recruitment and payment of teachers which would carry the authority to make the perhaps unpopular recommendations necessary to deal with a matter of urgent national importance.

Secondly I believe that industry must ask itself some searching questions. It is vital that industry should attract some of our best scientific talent. That we cannot question for a moment. But what we can reasonably urge is that industry should ask itself in its own ultimate interests whether every highly qualified scientist that it employs is really doing work that is worthy of him and could not be done by a less highly qualified person. When a commodity is in short supply we dare not even risk that any of it is being misapplied and no commodity is scarcer than scientific ability. Are we sure that there are not being attracted into industry by the lure of this word "research" men who will in fact be engaged in routine and repetitive work?

Thirdly I believe that the universities have a very significant part to play. Here again, we know that research is the life-blood of science, but today one must, in the light of one's own experience, ask whether all the young men who are staying on at the universities to do research are really as well employed as they might be. Has not it become almost too easy to do research? It is not credible that many of the people whom we have taught and know something about will make a significant contribution to scientific knowledge. They will not. Let them do their modest pieces of hack work by all means as part of their education, but let it be clearly understood, and let their university teachers tell them this unambiguously that the life of prolonged research is not for them. A positive campaign of recruitment carried out by university teachers in their laboratories would, I believe, have definite results for if there is one person who can influence the young science student it is the man whom he respects as a scientist himself. At present the university appointments boards arrange interviews and talks for almost every kind of career except one—teaching. The visits of practising teachers of the right kind to put the case for the profession, not only to those in education departments who have decided already that they are going to teach, but to all science undergraduates, is something that should become normal. This, I believe, would do more than almost any other solution.

It would certainly do more than the other solution which is often proposed, the provision of elementary science courses for those who have studied arts in school. Such a late transfer in my experience, is usually only really effective with the very

able person. By all means let us try it, but frankly I doubt whether its results will be as satisfactory as is sometimes supposed. For a university teacher to teach very elementary science is in general an expensive, uneducational and ineffective way of producing an indifferent product.

Although it is not directly the concern of this conference, I believe there are certain steps that we in the schools ought to take, for to some extent the present position represents a clear failure on our part. We have failed to present our own chosen career as a great and satisfying one with claims on the best qualities of mind and character. That is indisputable. It is our business to see that the conditions in our schools are as good as we can make them, though in the majority of schools that is something which to a great extent is a matter which is outside the power of individual teachers or head masters.

It is often contended that the schools could do more to divert suitable boys from arts to science, and the legend—for it is a legend—still persists that many of the best schools consciously discourage the ablest boys from a scientific career. Now such an attitude is, I think, much rarer than many people imagine, and I believe that the majority of schools would find it difficult, on grounds of aptitude or inclination, quickly to bring about any considerable deviation towards science, though such a deviation as part of the climate of opinion in the age is undoubtedly going on all the time. But to imagine—and to some extent I think the Report of the Advisory Council on Scientific Policy is to blame—that any sudden change in policy in the schools could cause a very rapid flow of boys from arts to science, even if that were desirable, is I think something like an illusion.

A much more fruitful line that has still to be explored concerns the early leavers. This is a problem that varies enormously from school to school, but it seems that there is little doubt that at the age of 15 or 16 there is a wastage of talent that, were it to remain in the school, would make a significant addition to our scientific manpower. On this problem a report is soon to be published, and we must hope that steps will be taken, for example by providing larger maintenance grants for sixth form pupils, if that is the way to enable us to stop this particular, and I should say significant, form of wastage.

Lastly I come to two other practical measures that would, I believe, have definite results. It should, I think, be made perfectly clear by the Ministry and by any other responsible bodies that the future prospects of a teacher will be in no way threatened if he enters teaching with no professional training. However much we may deplore it—and many of us

here do deplore it profoundly—it remains as a fact that many young scientists are simply not prepared to face a year in an education department and this applies particularly to the good ones who may have done a year or two of research. They would rather spend that year in further research or go straight into industry

Most important of all I believe that teaching for scientists should be accepted as a form of national service, and this, I think is the greatest single practical step that could be taken. I am utterly unimpressed by those who say that this would attract undesirable recruits, or that they would be looked down upon by their colleagues. Such simply was not our experience when we were for one year allowed to recruit in this way It did not work like that at all

Taken together at the lowest estimate these two measures would give us three valuable years of service from many young scientists, but I believe they would do far more. Many of the young men who would come to us for two years would realise what many of us know—that teaching in a good school is a great and satisfying career with its triumphs as great as those of the research worker its rewards less tangible but no less real than those of industry They would come for two years, but some of them would stay for life.

I have proposed some pretty simple steps that we might take I have not considered others of a much more radical nature, such as the concentration of sixth forms in special schools, that conceivably we may ultimately be driven to, because I believe that at the moment they would present educational problems and evils and dangers too great to make them practical I have suggested a number of small measures, not one of which in itself would be sufficient to relieve the situation But taken together taken with the encouragement and support of the academic opinion of which the universities are the representatives, I believe that those measures might do something to mitigate a state of affairs that threatens not only the schools, not only the universities, but the community itself.

Professor R E. PEIERLS C B E M.A. D.Phil. D.Sc. F R.S Professor of Mathematical Physics, University of Birmingham Like Dr James, I feel that I have only a number of minor points to make, none of which offers by itself a complete solution to this urgent problem. Moreover all these points are not new but have appeared in one or more places in the various documents dealing with this problem which we have all read. I shall try to stress a few of them which appear to me to be of particular importance, and I shall try not to repeat the many good points which

Dr James has already made, except where I have some comment to add.

I think one must be clear first of all, about whether the present shortage of scientists is a permanent feature or whether it is due to the present rapid expansion of the use of scientific manpower in industry and elsewhere. Some reports have suggested that the shortage may be over in a few years. If that were true then, of course the problem would mainly be one of diverting scientists to schoolteaching, and afterwards the problem would solve itself. I believe that this is not the position, that the demand for scientific manpower will continue, and that in fact there are very many places in industry and in other professions where people with a good scientific training could be extremely valuable. There is, of course, no point at present in suggesting their recruitment for those purposes, since it would only aggravate a situation which is already difficult enough. In the long run it is not a problem of diverting scientists (I am including mathematicians in that term) to teaching, but rather a problem of getting more of them, but clearly as long as there is a shortage, we must ensure that an adequate proportion of them are used for teaching, otherwise we shall be losing the opportunity of providing scientific manpower for the future.

Dr James has already referred to the practical short-term measure of making provision for students to enter the university who either have not taken science to the advanced level, or whose training has been inadequate, has covered the wrong branches of science for our purpose, or (I am afraid we have to face this situation) who come from a school where science has not been well taught. I agree with Dr James that it is not easy to expect people to start advanced science at the university if they have never had an interest in science. But I believe that there are many people who have an interest in science, who have perhaps done some reading of their own, but who could not take a science course at school, or not the right science course, because the school was not able to provide the teaching, or perhaps because at their school the course was not attractive. For those people an entry into what used to be called the intermediate course, preceding the normal honours course, would be very valuable. Whether this would be wise as a permanent feature one might dispute, but I have no doubt that for the present a greater use of such courses would be extremely helpful. If this were done we would also have an opportunity of seeing how it worked and making up our minds later whether we wanted to retain it as a permanent feature.

There would probably be some practical difficulties in carrying out such a measure. One is that the university course

would require normally four years, and there might be a difficulty in getting the necessary maintenance grants for the purpose. I believe that the practice of local education authorities varies very much in this respect some colleagues in other universities tell me that they have found little trouble in getting support for their students for the necessary four year course, but we certainly know of many cases in which this has proved difficult. If local education authorities could be persuaded to back students for the four year course, where this was necessary in the interests of the students education, that might help greatly in making a science course possible for students who otherwise were not suitably qualified.

In this respect also I have experience as no doubt have many of my colleagues, of pupils coming in from school with a very odd collection of advanced subjects. I have met students intending to go for a mathematics course who have, for example, learnt pure mathematics and physics but no applied mathematics, their third subject may have been French or music. When asked why it was that they chose that particular combination they said "Oh, I wanted to do applied mathematics, but our school was not able to teach it." One finds other odd combinations.

Very often such pupils come from schools in large cities where it would have been very easy to make arrangements for the pupil to get the extra subject at a technical college (which is very often done) or by an exchange arrangement in some other school close by or perhaps by transferring the pupil for the sixth form work to another school. I think it is very important that this should be done where it is necessary It might be argued that the prestige of the school would suffer if it admitted in this way that it was unable to teach a particular subject; but surely it would be all right if there were a mutual arrangement, with school A sending certain pupils to school B for some subjects and, conversely school B sending pupils to school A for others. We get this in the universities when one of our students wants to do research in a branch of the subject which we cannot adequately cover it is a matter of course for us to arrange a transfer to another university It would never occur to us to suggest to the student that he should take up a different subject because we happen not to be able to teach what he wants. I think that the schools ought to take a similar attitude.

Dr James said that this was a measure which might, if it came to the worst eventually have to be taken. I think the situation is such that it is extremely urgent that such a course be adopted now in many cases. Of course, there are many schools which are still able to teach all the subjects needed by their pupils, but for those schools which cannot do this

I think it is urgently necessary that some such arrangement should be made.

Another short-term measure might be to use the so-called "pass" degree course. Historically I believe, the honours courses were instituted as specialised courses for people who wanted to go into research or to the advanced parts of the subject, and originally it was never intended that school teachers should take honours degrees. What happened was that, particularly in the inter war years, when there was a shortage of jobs, schools tended to prefer the man with the honours degree—and perhaps the name "honours," which suggests a higher intellectual quality may have had some thing to do with it. Nowadays, of course, it is very hard for a person to get into a good grammar school if he only holds an ordinary degree. This is a vicious circle, because as a result of this position nobody who is intellectually capable of getting an honours degree will go for an ordinary degree course and therefore the employers and the schools naturally regard people with ordinary degrees with some suspicion.

As a short term measure there is the possibility of people transferring to school teaching who have been in other kinds of work. This might be a useful measure in some cases Very often an interest in educating young people, in passing on information and in getting people to see knowledge in the right way comes rather late in life their maturity and the experience they have had in other work, would be an asset in teaching I believe that the lack of experience in the school routine is something that can be made up for by the right people without great difficulty We have the parallel situation in the universities, where we all know of colleagues who have come back to university teaching after a long period in industry or in some other work, very often they are genuinely interested in education, and I am sure that they are as good teachers in general as those who have spent all their life in a university The practical measures that one might take to encourage this kind of transfer are matters which probably go beyond the scope of this conference.

On the question of long-term measures, I think that two things are important. One is to increase the number of students who take science courses at the universities. We simply cannot go on indefinitely with the present supply To some extent this supply is limited by the number of places in the universities. This was a limiting factor shortly after the war My impression now is that it is limited broadly speaking, by the number of boys and girls who come along with the right background, the right ability and the right qualifications, and that one could not solve the problem by creating more places. In spite of what Dr James said on this

point, I believe that there are still schools in which pupils are pressed into arts courses. I have personal experience of such cases, though when Dr James prefaces his statement by saying that this does not happen in the good schools, he may be right.

However I think that the major limiting factor is that there are boys and girls who try for admission to a science course in a university and who cannot get in because either they have not taken subjects at school which fit in with the university course, or they have not been sufficiently well taught in those subjects to reach the standards necessary for admission to the university There we come back to the point that a better supply of good teachers is an important factor- but it is also important to have facilities at the university level for people to make up what they lack. I think it is also important for the universities to review their selection procedure so as to detect the people who have the right quality of mind, who have the ability to do science, but who do not show up well in the G.C.E. examinations because they have been badly taught. I think that we ought to look not merely at the marks they have obtained (we do of course, take many other factors into account already) but also, in evaluating those marks, we should bear in mind the kind of training which has preceded them, and, other things being equal, I would be more impressed with the same mark if it came from a school which I regarded as very poor in its science teaching than I should be if it came from one of the really good schools.

In the long run, however I think the key factor is the prestige of the teachers. Dr James has already stressed this point, and it cannot be stressed enough. The difficulty in getting teachers lies in the fact that teaching is not in general regarded by the community in the light that it ought to be. What can one do to improve that? Salaries are certainly an important factor not merely because of the economic problem itself, but also because the salary which a community pays to teachers is a measure of the respect in which their services are held. Very many of our students with whom we discuss these matters do not consciously regard the salaries of teachers as the strongest argument against a teaching career but many of them have been prejudiced against teaching by the advice of their schoolmasters, who often tell them, "Whatever you do, for goodness sake do not become a teacher" I think that in that advice the present position about salaries plays a very large part.

We must be careful also to make sure that the profession of teacher is regarded generally in the right light. The suggestion has been made, for example, that we should increase the supply of teachers by being more selective in

accepting people for research, and that the borderline cases should be firmly told that they must not do research but should go into school teaching. I can think of few things more certain to provide poor teachers and to bring teaching into disrepute. I find often that people who are doubtful about their careers go along to some interview with a prospective employer or with the appointments board and come back a little discouraged and say "It does not look as if there are very good chances of my getting a job I am afraid it must be teaching for me." When people have that attitude I generally regard it as my duty to press them not to go into teaching but to see whether after all, there is not the right kind of job for them elsewhere. I do not think they would make the right sort of teachers.

What we must do is find more of the people who feel that teaching is interesting (there are some of them, fortunately) and give that view to more people. I do not think that we want to encourage the second-rate people to go into the schools. There are plenty of routine jobs for all kinds of scientists in industry and that is where the people of the lower intellectual standards belong; they can be extremely useful and happy there. The people who cannot get a job in industry or a research job because they are not bright enough, or if they can get a job will not settle down happily to do it because they cannot do it well enough, do not present a solution to the problem of the shortage of teachers; for it is a question ultimately not of the number of teachers, but of the number of good teachers.

There are some measures that can be taken to make the position of the teacher more attractive and the life of the teacher more interesting. The attraction of research has been mentioned. I think Dr James is right when he says that we must make it clear to people that research does not always have around it the glory that it so often has in their imagination They must know that as research men they would often merely keep in touch with what is going on, and contribute a little bit to the fund of knowledge, rather than start any new discoveries on their own The job of a schoolteacher might well compare with this in attractiveness if it were made easy also to keep in touch with modern developments. I think the suggestion either of refresher courses or as I would like to put it, the possibility of an occasional leave of absence from school which could be spent in doing work in a university department would be a very valuable opportunity This would not involve original research leading to discoveries, because the time would be too short, but work with the people in the university laboratory to bring the teacher up to date.

In some countries in which the prestige of the schoolteacher

in the community is very much higher this is in part because it is made harder not easier for a man to be a teacher For example, I believe that in Sweden there are certain posts in science teaching in schools—roughly corresponding to the position of a senior science master—for which one must have not only done university research, but qualified as a university lecturer only people with the status of a university lecturer are eligible for those posts. Of course, those posts are adequately paid but that is not the only point they are regarded as a sign of distinction and are hard to get, and it is for that reason that they attract men of the quality we would like to attract among our schoolteachers.

My last point is that everything I have said is based on the assumption that by some of these measures we can ultimately increase the supply of scientists to the required level. If that is not so, then we must reorganise the work in such a way as to require fewer people This might take the form, as Dr James suggested, of reducing the number of scientists in industry but I think one would also have to query whether one could not use fewer teachers more economically and more efficiently by combining permanently some of the sixth-form teaching from the smaller schools into larger units. These might be the new kind of centres which have been suggested, or they might be the first year courses in the universities, though either of course, would call for a great deal of reorganisation.

The CHAIRMAN We are fortunate in having present a number of invited guests in addition to the delegates from universities. In particular we have headmasters and head mistresses, and other masters and mistresses from schools, and also visitors from Commonwealth and American universities. It is in the tradition of this conference that we welcome, and indeed more than welcome, remarks from the guests at least as much as from the delegates from universities.

Professor W M SMART (*Glasgow*) In the remarks that I shall make, I shall refer to Scottish schools only Through the kind offices of the Royal Society of Edinburgh, I have had the privilege of visiting something like fifty schools north of the Tweed in the last ten years, and I have had first-hand experience of the difficulties that we have been discussing this afternoon.

It is true that in the Scottish universities there is a shortage of students going in for teaching, but paradoxically enough, according to calculations I have been making, there is not a marked shortage of mathematics teachers at the present time —perhaps this applies to some extent also to science teachers.

What happens? When an education authority discovers a first-rate teacher it makes him a headmaster and this promotion cuts him off from teaching straight away. In all the schools which I visited, from north of Aberdeenshire right down to the Solway I met only two headmasters who taught at all, and they spent as little as two hours a day on the average in teaching. I think that is a most deplorable situation.

In the great cities and in great education authority centres headmasters have very little status. I can quote several large education authorities where the head master is never consulted for example, about the appointment of his assistants. That, again, is deplorable. Many headmasters tell me, and I am sure they tell other parents, that they insist on their own children avoiding the teaching profession, and if this attitude is general, it is not surprising that there is a scarcity of entrants to the profession.

Dr James and Professor Peierls referred to "prestige." I am sure that, whatever the prestige of the teaching profession was twenty or thirty years ago it is ever so much lower at the present time. Take the average headmaster. He does no teaching; he has a large number of forms to fill up in the course of the day he has all sorts of finicky little duties connected with milk and what not. How can he be expected to run a school efficiently? I was in a school as recently as last Tuesday giving a lecture. It is a secondary school, having between 1 000 and 1,200 boys and girls. It has no assembly hall, and the only way the headmaster can make himself heard or known is by an inter-com system. When I was there he addressed the school. His voice was known to the children, but I would not be surprised if half the children failed to recognise him in the flesh. I think it is essential that, where there are these conditions, they should be altered straight away. No wonder the young people in the universities regard unfavourably the prestige of the teaching profession.

Dr James referred to the appeal of research. I do not think that is particularly valid because the best students in the universities who are good enough for research join university staffs, the higher branches of the Civil Service, or industrial firms. The very good second-class honours man may on very infrequent occasions, be a very good researcher —I have known one or two of that kind—but, generally speaking, the word "research" is one that we ought to avoid in this connection

Both Dr James and Professor Peierls have referred to salaries. I think that one way in which the prestige of the teaching profession might be greatly improved, and a way by which many misapprehensions of possible entrants to the

profession might be removed would be to adopt the same system as we have in the universities We have junior lecturers senior lecturers, readers, professors. Why not have a similar system in the teaching profession, with grades of junior senior and principal teacher and headmaster promotion being by merit and seniority?

Dr James mentioned the part of the universities in regard to propaganda. In the Scottish universities a young man can get an honours degree in mathematics and astronomy I have not a very large number of honours students each year but if they ask my advice I tell them that this is the time to go in for teaching, that here is a golden opportunity created by the great shortage of new entrants. I think that perhaps other university people might adopt this attitude as well.

One thing that deters many young people from going into the teaching profession is the postgraduate year which honours students are forced to spend in a training college Students tell me that although in one or two courses they get something of real value, much of the time is regarded as wasted it is quite possible that one term would be sufficient for the purpose in view If the training period were drastically curtailed, I think that one deterrent would be removed Without this compulsory training year the Scottish Education Department will not recognise as valid any application for a post in a school even a professor however eminent, would fail to satisfy the authorities as to his competence.

Dr G B Jeffery (*London*) Having listened to Dr James and having agreed wholeheartedly with everything that he said with the exception of two sentences, it would perhaps be a little ungrateful if I said too much about those two sentences.

Dr James, as a science graduate did give us an example of a very fine lesson It was well spoken it was heard the argument came over clearly and forcefully and he left us all I think, with the sense that he was presenting to us the conclusions of a sincere mind—and that, Sir is a very good specification of a good lesson. And it was given to us by a science graduate. The power to do that kind of thing is not possessed by all science graduates even graduates in science of many years standing and experience, and if Dr James thinks that our graduates in science, as they leave our universities, have or can easily acquire without assistance the kind of gift that he displayed I think we ought to disabuse him they cannot. I think that this particular point, which I am not going to labour further now has an indirect application to this problem.

In the course of this term I have written personally addressed and signed letters to 500 undergraduates in science

of this University who will be taking their final degree examinations in science next summer and in writing to them I did the best that I could to state precisely the case that Dr James stated to us for the claims of the teaching profession. I would like to think—but unfortunately I have no evidence at all—that that effort is going to produce as much as half a dozen people for the teaching of science in our schools but it has landed me with a certain amount of most interesting correspondence, for some of these youngsters have written to me fairly frankly and fully of the balance of argument in their minds as they are facing this very important question of the choice of a career

I am left with no doubt at all that one of the major difficulties at the root of this business is the kind of thing that is said day by day in our scientific laboratories in our own universities It is said, on one ground or another to the young scientist, "Do this, do the other thing; if all these things fail, at least there is always teaching." There are exceptions to that rule, but from all that I know that is what we, as universities, are doing towards this problem at the moment. We are actively discouraging young scientists from a career of teaching science in the schools. That is not, I think, just a matter of settled judgment, much less a matter of malice, it is because the teaching profession has become, in the eyes of university people and of scientific people in this country generally a profession which it is very easy to enter it is easy to go in for a few months while hoping that the right job will turn up.

I think that this vexed question of training has some bearing on that, and I will dispute with Dr James in another place whether the training we give is the right kind of training—that is neither here nor there But a profession which is a serious job in life and which requires adequate preparation before you undertake it, is one kind of profession in the eyes of a young man or a young woman, a profession which is always there as a place of refuge if you cannot get something else is an entirely different story Therefore, far from attempting to meet this very grave national emergency by making it easier and easier to get into the teaching profession, I believe that is the very root of a good deal of our trouble. Our difficulties will lessen to the degree to which we are able to present the teaching profession as one of high responsibility and one requiring serious preparation.

Professor BRYNMOR JONES (*Hull*) When my university allows me the freedom I am a chemist. I ought perhaps to add two other things about myself, since they have a bearing on what I have to say in this discussion. Many years ago I

took the diploma course in education, and I started chemistry at seventeen.

Dr James has urged that science professors should help to recruit teachers by speaking themselves to their students about the value and importance of teaching as a profession. For some years I have done this with my finalists, and it may be of interest if I try to summarise some of the impressions I have formed from discussions with some hundreds of students.

In his address Dr James has attributed the aversion to teaching on the part of science students to three reasons. As to the first of these—finance—he is right in saying that this is not the sole nor indeed the main deterrent The initial salary of a science teacher today is not very different from that of a young graduate in industry or in one of the Government Research Establishments. The recent improvements in the salaries of teachers have substantially reduced the old differences, but the maximum to which the scientist in industry can generally rise remains at a much higher level. On the financial side it is this more than the initial salary that acts as a deterrent today

It is true, as Dr James has said that the appeal of research is strong There is about scientific research today a sense of glamour—and I use that word in its best sense During his degree work an undergraduate is given an insight into the most recent advances in his subject, and it is perfectly natural that he should be keen to join in the search for new knowledge and for new ways of applying existing knowledge. The two or three years spent working for a higher degree in a university laboratory can be very stimulating ones to the young graduate for in addition to the feeling that he is working on the frontier of at least one branch of his subject, many a young man derives great pleasure and satisfaction from constructing and handling delicate and precise apparatus. To some degree the same feeling is experienced by many R.A.F pilots

Despite what has been said this afternoon about the appeal of research, it is nevertheless something which the universities must not belittle or weaken, for surely one of the prime functions of a university is the production of scholars. It has not infrequently been implied in recent months that the universities allow too many graduates to embark on a period of research training, thereby reducing the number that go in for teaching. I doubt whether many of these young men and women would enter the teaching profession even if they were not accepted as research students. The majority of them look to industry and to the universities for their future employment, and from the side of the university it must be realised that it is extremely difficult to decide on the basis of performance in a first degree examination, which of a number of

possible research students are the ones most likely to develop into the able and independent researchers that the country needs in this highly competitive age. More often than is realised, those who do not show promise of developing into original workers are advised by their supervisors to think of other forms of employment at the end of the first or second year

A great many students join industrial firms because they offer opportunities of research in a variety of fields. Many expect to be engaged on fundamental problems, only to find that they are engaged on investigations of a rather routine kind Industry should appreciate and use more extensively the third-class graduates who with able and intelligent leader ship, are capable of tackling many of the problems that await solution in the industrial fields. This would at least help in the better distribution and employment of the more able men.

A powerful deterrent with many students today is the feeling that the schoolteacher like the country parson, has lost prestige. I am not thinking here of schools like Manchester Grammar School, but of our smaller grammar schools where the shortage of science teachers is most acute. This loss of prestige arises in part from the present salaries (especially the maximum) but it also arises from the fact that in recent years the community at large has not shown any visible and genuine appreciation of the services of the schoolmaster The con ditions of service of science teachers in many schools often heighten their depression. Like Professor Smart, I have been to many schools recently and, while I found that some had modern, well-furnished laboratories, others had old and inadequately equipped accommodation for practical work. In far too few schools are there laboratory assistants, and a science teacher feels that he has to do everything single handed. Without assistance he has to prepare the experiments and, at the end of the day he has to clear the laboratory and often set up new demonstrations for the following day Compared with the scientist in industry the schoolteacher is here under a great disadvantage.

I said earlier that I started chemistry at seventeen. I should like to ask the schools whether in view of the present shortage of science teachers, it is really necessary to start teaching science to children at eleven. Many science graduates in my experience cannot contemplate a return to the schools to teach the most junior forms; and their reluctance is understandable. After some years in a university department in constant touch with a rapidly growing science, the prospect of teaching junior forms in a small town far removed from a university centre or a good civic library and under the conditions I have

mentioned, can only be faced if the graduate is exceptionally interested in the young.

I should like Dr James and others to consider very seriously whether science teaching could not be done more efficiently and at least with more satisfaction to the teacher if it were started at fourteen. At this age the children would have more developed minds, they would have had more time for their non-scientific subjects, and the years lost to science could be redeemed by teaching at a greater tempo

Professor Jeffery has replied to Dr James's comments on the value of the diploma in education As a scientist I should like to say a few words in support of some measure of training in the art of teaching. I am sure that the great bulk of science graduates—indeed the majority of all graduates today—cannot immediately on graduation teach effectively The need to spend a year on such a course has not from my observations deterred many from entering the teaching profession. I am not suggesting here that all is well with the diploma course, nor that it is not capable of improvement—it might in the present emergency be shortened and intensified—but because of the high degree of specialisation which there is in university science teaching today the diploma course is of value in that it emphasises other aspects of life and prepares graduates for the teaching profession Why should it be assumed that the art of teaching can be acquired without some preparation?

Professor Smart spoke about headmasters in Scotland In England the majority of our young science graduates continue to believe that their prospects of promotion to headships are less rosy than those of their arts colleagues. If the under graduates could be convinced that the scientist stood an equal chance for promotion as heads inspectors, and directors of education then at least a number of those who now take up industrial posts might well become teachers

The CHAIRMAN Dr James, who is having a characteristic day has to make a speech in Manchester this evening and I will give him three minutes to comment on the discussion so far before going to his train.

DR. E. J F JAMES, in replying to the discussion, said There are two or three points I would like to clear up. The first concerns the training year I would hate to give anyone the impression that I was attacking the idea of training for teachers. It was very kind of Dr Jeffery to say that I had given a good lesson. I have no doubt that I could have given a much better lesson if I had ever had any training as a teacher! What I am trying to do is to state a fact. However much value one may put on the training of teachers, I know

chaps who have done one year's research to get an M.Sc. or two years to get a Ph.D and they say "No I am not going to do that year's training." That is all. Those are men who might be valuable. One may blame them for that attitude, but it is a fact. Of course we have got to go on with our training of teachers, and we have got to get as many scientists to undergo it as we can, but we must give a loophole for the oddity—who is often a pretty good oddity too—who likes his research, who wants to go into a school but who is not prepared to face that year

I want also to clear up a misapprehension about research. I am steering a very tricky course here, for I do not exactly want the universities to say to a chap, as they have said far too often, "You are not good enough for research, so go and be a teacher " I do not want exactly that. On the other hand manifestly there are some people who are very good research workers, they will end up as Fellows of the Royal Society and all that. It is no good saying to such a man, "Be a schoolmaster "—because he will not be. He is a very gifted scientist, and it is no use saying that to him. There are, however people who are quite good enough to do one of the bits of research that people *do for an M.Sc. or a Ph.D* let them do it and regard it as a valuable part of their education, but let them also take it as quite a normal thing for them to be schoolmasters in the end and not feel that those wonderful years of research have been, as it were, wasted unless they go into I.C.I. It is possible to draw a line between the really good man who must at all costs be kept in research and the pretty good man often with very good qualities of character and fairly decent mind, who is not original and never will be—and this is autobiographical!—who ought to be a school master

The third point with which I want to deal is the age of starting. Professor Brynmor Jones raised a very interesting question to which I would not like to give a dogmatic answer Of course, in many of our best schools we do start boys on science at fourteen. That is precisely what some of the great independent schools are criticised for doing by the Advisory Council on Scientific Policy Those schools do produce very great scientists. Only a pretty intelligent chap could begin chemistry at the age of 17 and do it well. I say that quite frankly and honestly because it is true.

Professor Brynmor Jones (*Hull*) I was thinking of 14

Dr James: The age of 14 might do. But let us remember that we are concerned with a lot of youngsters in maintained grammar schools all over the country an undue proportion of whom leave school at 15 or 16. Is a boy going to like science as much as in fact he might do if we do not start him on

science till the age of 14? Between the ages of 11 and 13 the boys are very scientifically minded with an interest in jet aircraft and space-ships, and so on It is a good age to cash in on the wonder and the excitement of discovery I am sure that we are catching a lot of boys for science by teaching them what we call general science at the age of 12 or 13 and they love doing it. Although I would hate to be dogmatic, I think we should lose many of them if we were to postpone the teaching of science to them until they are 14 Of course, we may have to do that. It is one of the revolutionary ways of saving scientific manpower On the other hand some of the science graduates we are getting now are only equipped to teach children between the ages of 11 and 14 anyway!

Dr R. Birley (*Eton College*) I think that we ought to realise that we are well and thoroughly in a vicious circle in this matter It has all the elements of a vicious circle. The fewer teachers we get, the fewer boys and girls will be taught to be scientists and so we shall get fewer teachers, and so on. It has one particular sign of a vicious circle, and that is that we say a very great many things on which we all agree about it, but that does not seem to make much difference.

To give one example, it was suggested that we ought to persuade more of the really able boys to go on the science rather than the arts side. I suppose that we all realise that will not do the least good for the purpose of this problem, because if we do that we can be quite certain that they will not be science teachers. In the same way if we try to introduce a lower quality of science teachers in the schools, if we go for pass degree men, we can be perfectly certain that able boys will not want to learn science.

If then, we are faced as we are, with a vicious circle we have to consider that there are, I suppose, two ways of dealing with it. One is to break it violently from outside by doing something which is quite revolutionary I do not know whether it would have that effect if for example, the salaries of science masters in the grammar schools were doubled. Something like that, I suppose would be necessary though, of course one realises perfectly well that for political and for other reasons it would be quite impossible.

I do not think we should ignore certain suggestions which have been made and which at any rate might help to tide things over for a time I hope that two suggestions made by Dr James will be taken seriously The first is that future science teachers should not necessarily have to spend a year taking the diploma of education. It is not necessary at all to feel hostile to the diploma to think that that is not essential We all know that it is stopping able people becoming science

teachers. I hope also that we will consider although in some ways it is distasteful—as it is to me—the possibility of those who teach science being exempted from the two years national service. I can take that attitude myself only because I know quite well that those young men will not, in fact, serve in the Army the Navy or the Air Force if there is another war they will inevitably be used as scientists. It seems to me that it would be possible to find some way by which during the holidays they would spend a certain amount of time preparing themselves for the kind of scientific work that would be needed of them so that they would still feel that they were doing some kind of training for national service. I think that would help the problem but it would not do more than just help for a little while.

I am also wholly in favour of postponing the beginning of science teaching till the age of 14 I suppose that is because I come from the kind of school where that is perfectly normal. I do not think so much is gained by starting at 11 and in the present desperate circumstances it seems to me that that is an obvious economy but it would not solve the problem.

The other way one could do something, although it would take much longer is by changing the whole atmosphere which has created the vicious circle. That, I am sure, is what will have to be done in the end and nothing else will solve the problem. I will give one example of the kind of thing I have in mind. I think you have to consider first of all what in fact it is that makes a man want to teach. It is much too difficult and complex a question to go into now but I know of one able young chemist who has been secured recently by a large grammar school. They played their fish with extreme care, as you can imagine. He was engaged long before it was known what class he would get in his honours degree It would have been foolish to have waited until then He wanted to teach in school, and he resisted very considerable pressure from various large firms which wanted to secure his services as a research chemist. I have not the least doubt that the main reason was that he had rowed bow in his college boat and he was going to a school where they had rowing If he had found out, what he probably did not know that the very harmless sounding boat called *Lensbury* as a matter of fact masks I.C.I. I doubt whether the school would have got him! Whether you think that is a good reason or not is perhaps neither here nor there, but it is one of the curious reasons which will make a man decide that he wants to become a teacher and I do not think one can ignore that kind of thing.

After all, the great classical and historical teachers of the past might well have been the kind of people who had only been interested in research, they gave up that because, I

suppose, they were passionately concerned about seeing that other people became interested in classics and in history That is the kind of person we want. That is why I believe there really is a certain lack of faith in the subject on the part of science teachers. It seems to me that to show a real faith in your subject you not only want to study it yourself because you find it interesting, but you will also want desperately to make other people interested in it as well. There is not only a lack of desire to teach, but a certain lack of missionary spirit among scientists which I regard as very significant, and in some ways perhaps rather sinister I believe that the whole nature of the teaching which we give scientists in schools and perhaps—it is not for me to speak about that—also to some extent in the universities has a great deal to do with this It is very largely because the education we give them is inevitably as things are now often so extraordinarily narrow that they do not become the sort of people who would want to become teachers. I have no doubt that a broader education and a more humane education for many scientists in many grammar schools would do more than anything else in the end to make some of them want to become teachers. I have no doubt that is partly the responsibility of the schools and if things have gone wrong it is no doubt partly they who are to blame, but I am certain it is also the responsibility of the universities and that to some extent they are to blame. Before we begin to tackle this vicious circle, we shall have to tackle another one, and that is the continuing demand for more and more highly specialised work in science on the part of boys and girls while at school if they are going to get into the universities. If that could be dealt with, I should think that eventually we would have dealt with the problem of the science teachers.

Professor H A. HEILBRONN (*Bristol*) There is one thing which some universities can do to improve this situation without outside help. I am referring to the general science degree with honours. My own university Bristol, has such a degree London has it, and other universities have it.

Before I came to this conference I looked up the figures of recruitment to science teaching in schools. The results are striking. Of the general science students who had obtained an honours degree, 25 per cent. went into schoolteaching of the special school honours degrees, 8 per cent. went into schoolteaching The lesson is obvious. We must try to recruit more students to our general science courses where these courses exist.

Another argument which influences my view on this is that we have found that we cannot find many applicants for the

special school with suitable qualifications beyond those whom we can take. We have found that in general science we could easily treble the number of acceptances if we had the places available

This is a small point, but it is one that many of us could do something about immediately

Dr P DUNSHEATH (*London*) The most significant factor in the problem of the shortage of science teachers today is its complexity for its wide interest has involved a number of different bodies concerned in finding the solution. Primarily an educational matter it has such dangerous implications in industry that the Federation of British Industries recently became active in setting up a committee of industrial and educational representatives to go into the whole problem. They issued a report* which we hope has had some influence on views in this field.

The various opinions which have been expressed and the remedies suggested have often carried the problem from one sphere to another backwards and forwards—from the Ministry of Education to the Ministry of Labour from department to department, from the universities to the schools. We have heard this again today The problem affects, on the one hand, employers, the L.E.A.s, the governing bodies of colleges, and industrial boards of management, and on the other hand the employees, represented by the trade unions of teachers and the teachers associations. While therefore, *this conference is obviously primarily concerned with the university aspect*, I am encouraged by what has been said both by the opening speakers and by Dr Birley to believe that the problem we should discuss here today is a little beyond just the effect on the universities.

It is for those reasons, therefore, that I was glad to hear references to national service. I was also very interested to hear Dr James suggest that possibly industry could contribute quite a lot by using its scientists more profitably and not taking from the pool available more than was absolutely necessary Perhaps it is on that aspect that I can contribute most to this discussion, because I should like to point out some of the real difficulties that industry has today in contributing in this way

First, I must emphasise that industry is not organised by one committee or one council which could arrive at some desirable method of procedure and then promulgate its decisions to the whole of industry There are large numbers

* *The Shortage of Science Teachers.* Report of Committee set up by *resolution of a conference convened by the Federation of British* Industries. (F.B.I., London, 1954.)

of autonomous bodies each employing scientists, each one paying what wages it thinks necessary to secure their services, and providing conditions of employment more or less attractive depending on the economic position.

Further we must face the fact that in industry there is no general acceptance of responsibility for the shortage of science teachers rather as one goes about, one hears that the educator should be educating for society as it is and that as society has become completely dependent on the application of science, any failure in the structure for teaching science is a failure of the educational system. It is a view which is being canvassed widely in circles where it is suggested that industry should give assistance in meeting this urgent situation

There are many other difficulties in industry which must be considered by anyone in these other fields of interest who says that industry must help by doing this or doing that. During the past two or three years industry has been pressed by statements from the National Advisory Council on Scientific Policy and by F.B.I documents to use more and more scientists, and it is quite impossible to go into reverse on such a policy in the period available for meeting this crisis.

Further there have been such rapid developments in the application of science throughout industry that the requirements, even had this present problem not arisen, would still have been far beyond the available supply of scientists. I differ therefore from one speaker who seemed to visualise this problem as being a short-term problem. It is not. The shortage of scientists in industry will continue for many decades to come. Take one industry for which figures are published widely the electrical industry In that industry there is a regular 8 per cent. expansion every year and it requires far more scientists of the necessary standard than it is able to recruit.

As an indication of what is happening on a world basis, there is at the present time in this country an agent from one of the Dominions looking for 150 science graduates required for an engineering project in that Dominion. There have been other cases of this kind, and it is an important matter for consideration when we discuss the question of salaries. If we say let industry restrict its salaries so as to encourage scientists not to go into industry but to go into teaching, the result would not be that at all. Any who were discouraged from going into industry would go abroad or into other fields of activity not into low-paid teaching.

I have taken the opportunity recently of considering some specimen salaries paid to scientist graduates in this country and one very significant thing is the wide variety of treatment

being accorded to these people by different industrial concerns. I found that in eight samples taken over quite a broad range of industry during the training period—that is, coming straight from the university for a period of one or in some cases two years—these young men were being paid starting salaries of £420 to £600 and then being offered first posts starting from £470 to £1,200

You may say I have proved that industry is not very likely to help by discouraging scientists from going into industrial employment.

It is interesting to note, however that certain individual concerns in industry today are doing something in this direction. A few firms are at the present time diluting their high-grade scientists with technicians, not because they are convinced that here is a good cause, but from sheer necessity One firm set up some very expensive oil-cracking plant in this country and before the plant was completely installed every single scientist had left the job to go abroad, and much of that plant, costing large sums of money running into millions of pounds, is now being run by raw recruits from the scientific courses at the university

I have quoted these instances to indicate that industry is itself having a difficult time, and it is rather inopportune to ask industry to do much in the way of helping in this problem. At the same time, some firms are releasing scientists on Saturday mornings to teach in the local grammar school. It is clear from what has been said this afternoon that many of you would not consider they would be very good teachers, and probably many of them are not, but it does indicate a willingness on the part of industry

Finally I want to refer to the question of modified national service, because in my opinion and in the opinion of many people with whom I have discussed this matter this offers the only quick solution. I quote from a letter to the Minister of Education written as long ago as May 1954 and printed as an appendix to the F.B.I. report

> "The committee feels that the advantages which deferment offers could be obtained in a much more satisfactory way by limiting the period of full-time National Service. The committee therefore recommends that graduates in science and mathematics who undertake to teach these subjects in schools and have obtained suitable appointments should be granted release at the end of the period required for basic Service training. The committee believes this proposal is a remedy which could be applied effectively and without delay It could produce a number of men in time for the autumn opening of the schools this year from amongst those already engaged in the Services and could provide a continuing stream for as long as desired."

That quotation provides further evidence in support of my general argument that this is a complex problem, and it is quite useless to try to solve it in the universities alone in the schools, in industry in the associations of teachers, or in any other restricted sphere. It involves, I believe setting up some senior over riding organisation which can consider the problem in its entirety We are so often told when we suggest a solution, "Yes, but that is not the whole story" because in the particular field in which we are discussing the question we are omitting some problem in some other related field. I think that we must find some way of bringing together the ministries concerned, the schools and the universities only by such means can the problem be solved in a states manlike manner

Dr C. L. Wilson (*Queen's Belfast*) I have a certain hesitation in speaking to this conference, because I know that a great many people who visit us in the North of Ireland think there is not merely one great gulf, but many great gulfs, fixed between us and our colleagues in Great Britain And there are indeed certain aspects of this problem which are not completely common to the two countries For example one finds that in the North of Ireland there is not strictly speaking a shortage of science teachers but when the point is pressed it must be admitted that there is a shortage of good science teachers. In other words, we are only one stage off being in the same condition that exists in Great Britain and by and large we are merely putting people into teaching when we cannot get them in anywhere else.

It seems to me that in getting good men into science teaching there are two problems, problems which have already been referred to repeatedly—the problem of finance and the problem of research. Now in Northern Ireland, the salary scales at the top so far as I can gather are slightly more attractive than they are in Great Britain they are slightly less attractive at the bottom of the scales. From talking to students as adviser of studies, I am afraid that the financial problem is by far the major factor in most students minds. Undoubtedly teachers salaries compare unfavourably with the comparable rewards in industry But the problem of research to which Dr James referred, is one that should certainly be taken into account also.

The Regius Professor of Astronomy at Glasgow said, I believe that we should not think of research in connection with prospective or actual teachers. It may be that it is not so easy to do research in let us say astronomy in a school but in my own subject, chemistry I think there is a consider able opportunity for smaller pieces of research to be carried

out in schools, in collaboration with the local universities, if the facilities are provided for the teacher

From time to time I have raised this question, both publicly and privately with teachers in Northern Ireland They have always said that it sounds lovely but they have also shown that they regarded me as a completely starry-eyed idealist because as they point out, they have neither the time nor the apparatus to do the research. My answer to them has been that, as far as the apparatus and laboratories are concerned, in many cases the schools have better laboratories than the university This may be exaggerating to some extent but not to such a great extent at the moment. And in any case there are many problems in my own subject on which research can be carried out with a very small amount of equipment. A greater problem is that of time. Teachers who are occupied by their teaching duties for perhaps 48 or 55 hours in one week clearly cannot tackle any problems of research, however small.

Local education authorities should be encouraged to realise that a good man coming from the university will still have an interest in research. Not only will he have that interest himself but he can foster it in his pupils. They may then go on to regard teaching as a vocation which can, in addition, provide them with research opportunities, even if only in a very small way Part of the discontent which has been referred to as being communicated from teachers to pupils thus putting them off the teaching profession, arises from the fact that men with good honours degrees, who had the ability and inclination to go on to do research, have been forced into teaching—let us say at the time of the depression—and have found that their whole natural trend of mental development has been completely stultified With a little co-operation some opportunity could have been provided to enable them, in conjunction with the universities, to develop themselves by work on smaller problems in the manner I have suggested.

Professor H. W B SKINNER (*Liverpool*) We have heard much discussion this afternoon about how we might persuade science graduates who otherwise would go into industry to go into school teaching instead. I wonder whether the magnitude of this problem is realised. At the moment we are providing about 500 science teachers per year of on the whole, very inadequate quality Over the next five years we ought to provide according to the figures published, 1,000 per year I think we agree that there is really no hope of our doing this out of the 3,000-odd science graduates which the universities are producing. The only really effective short-

term measure is the one stressed by a previous speaker—the remission of national service in some form or another This, coupled perhaps with increased pay is about the only thing we can do

However even this will certainly not be enough, and of course the reason is that the problem of the schoolteachers is merely a symptom of the general shortage of scientists which our educational system has turned out and is turning out at the moment. There is no real solution to the matter other than providing, let us say 2 per cent. of the population with scientific training, instead of about 1 per cent. as at present. This figure has to be compared with the figure of 3 per cent. in the United States of America and, according to what I read in a newspaper recently an even higher figure in Russia. Until we increase our numbers we shall not have solved the problem of our scientific manpower generally and certainly not the problem of teachers of science.

This means that in the short term we must make every effort to economise in the use of the teachers that we have, and several suggestions have been made some of which I think are good For instance there is no need to start teaching children science at 11 Professor Peierls also suggested the grouping of schools into bigger units for science teaching. I think this should be tried. I think the universities themselves should expand their intermediate courses as far as possible so as to pick up as many as possible of the people who have been badly taught or even perhaps not taught at all up to the G.C.E. higher level standard. At Liverpool this is the policy of the science faculty and we have made a start already

With such measures we may perhaps pull through, but the main objective should be to multiply the number of technologically educated people which we produce in the country The eye must be on this ball the whole time. Certainly it would be a good thing if, as was suggested, a commission of all the interested parties could be got together to look at the problem as a whole.

Professor R. E. PEIERLS, in replying to the discussion, said I would like to reply briefly to one or two points. First, on the question of starting scientific education at 11 or at 14 I think it may well be that the future scientist can start at 14 and, in a concentrated scientific training, get the necessary background in time. That is certainly possible. However we must not forget the person who is not going to be a scientist and who now has only far too little acquaintance with science. For those people it would be too late,

because they have other things to learn at the age of 14 and later

This brings me to the point made by Dr Birley This has no direct connection with our subject, but I do not think I would like to let his statement about the narrow education of scientists pass unchallenged. This is true to some extent, but I think there is a far greater danger of people on the other side completely lacking in any knowledge of the principles of science—and starting science teaching at 14 would make this very much worse.

The CHAIRMAN I know that you will all wish to express very warm thanks indeed to our opening speakers and also to the invited guests who have so nobly come forward and contributed to this discussion

SECOND SESSION

SATURDAY MORNING DECEMBER 18TH

ARE UNDERGRADUATE COURSES OF STUDY OVERLOADED?

Chairman R. NIKLAUS, B.A., Ph.D., L. es L., Professor of French, University College of the South West of England, Exeter and President, Association of University Teachers

The following notes were circulated prior to the conference —

A. Summary of Address by Mr J F WOLFENDEN

Perhaps we ought to distinguish

(i) The prescribed syllabus.
(ii) The amount of work which this syllabus involves.
(iii) What the student is actually required to do.

(i) is seldom, in the arts faculties, excessive But this is often because it does not reveal what is involved in it—e.g. background reading.

(ii) usually means much more than is actually prescribed so that the student feels insecure and sometimes deceived.

(iii) is greater than either (i) or (ii). The real question is whether or not (iii) is excessive.

In arts faculties I do not believe that it is Fortunately these departments are usually dealing with a finite content they do not necessarily as the sciences apparently do add considerable quantitative bulk year by year

But there are two dangers. *(a)* Should we try to make up in the degree courses, what we believe to be inadequacy in the specialist training in sixth forms? Clearly some sixth forms are better than others and we run the opposite risks of either assuming in all students what has been achieved only by some or of gearing our courses to what can be assumed of all. My preference would be for assuming a good deal and trying to bring sixth forms up to this standard. *(b)* Do we overlook the general education of our students and crowd it out by our specialist requirements? I do not believe in sticking on extraneous and irrelevant slabs of "culture"

I do not think that this is for the university to prescribe, though it can and should provide the opportunities.

Broadly I doubt if the arts student in an honours school is over-pressed by what is academically required of him.

B. Notes for Address by Professor H. S. W. MASSEY

1. Requirements of university undergraduate courses in science subjects

(a) Realisation of the full cultural value of the subject.
(b) Need for proper balance between training in principles and technique.
(c) Proper emphasis on both theoretical and practical sides of the subject.
(d) Need to glimpse at some stage the present boundaries of the subject.
(e) Need to deal with students whose interests and natural abilities, though appropriate for the subject, are nevertheless rather varied.

2. The special problems of science students

(a) Practical work.
(b) The third year—difficulty of choosing a syllabus in a rapidly advancing subject.

3. Can a satisfactory science course be provided in three years without overloading the student?

4. Existing science courses.

5. Relation of the problems for science students to those of students in other faculties.

The CHAIRMAN. I should like to preface my remarks this morning by saying how deeply honoured I am, as President of the Association of University Teachers, to be invited to take the chair at the present session of the Home Universities Conference. It is gratifying to note that the Committee of Vice-Chancellors and Principals realises, perhaps through perusal of our *Universities Review*, how deeply the Association of University Teachers is interested in all matters affecting university life, and that it is not exclusively concerned with matters of salary and grading and negotiating machinery—to use graceless but commonly accepted terms. Recent newspaper articles and current rumours have not blinded them to this truth.

This morning we are gathered to discuss a topic which will strike some as a hardy perennial. Certainly the question of the overloading of undergraduate courses has been raised

before in many quarters and in different contexts, but perhaps never before with the same urgency—or so at least it seems to me, busy as I am now in drawing up ideal syllabuses for the day when the college to which I am attached may receive a Royal Charter

The problem posed may not be capable of ready solution If, however it were once agreed that courses are overloaded, the remedy which may vary according to the subjects or the faculties concerned, should be within our compass, even if it were found that the problem is more intractable in the sciences than in the arts. There is this much to be said. Our question this morning is a direct one should the answer be equally direct, something practical can and must be done to set things right.

It is self-evident that the curricula prepared for under graduates must be related to school curricula and what can legitimately be expected of a fresher as well as to academic requirements in all faculties. This being so we are fortunate in having with us Mr Wolfenden, the Vice-Chancellor of the University of Reading and present Chairman of the Secondary School Examinations Council, and former headmaster of Uppingham and Shrewsbury who will open our proceedings. He will be followed by Professor Massey who is Quain Professor of Physics at University College London. We all know that in 1930 a great revolution took place in the world of physics, and that since then the amount of knowledge that students are expected to assimilate in this subject has increased rapidly and probably more so than in any of the other sciences. Professor Massey who has interested himself in both theoretical and experimental physics, has clearly an important contribution to make to the subject to be discussed

Without more ado I now call on Mr Wolfenden to address the conference

J F WOLFENDEN C.B.E., M.A., Vice-Chancellor Univer sity of Reading I take it that my prime function this morning is to open a discussion, and I therefore propose to be very brief in what I have to say The consequence of that may well be that I shall be more, or shall seem to be more, dogmatic and complacent than I really am, or at any rate than I should wish to be thought to be. This is a difficult subject, and I think that, if decent brevity is to be observed a certain amount of dogmatism is going to be unavoidable. Moreover it is almost exactly twenty years ago that I ceased to be a full-time university teacher and it may therefore be that since then some of my notions have not advanced very much. Since then I have only had the two receptive phases of being connected with schools on the one

hand and becoming a full-time administrator on the other Than that last there can, of course, in such a company as this be no more frightful fate.

I do not, therefore propose to say very much in amplification of the notes which are printed in the programme, but should prefer if I may to take a little further the dangers at which I hint at the end of them. Let me look at the first one mentioned there the question of whether we should try to make up in our degree courses what some people feel to be the inadequacy of the specialist training in some sixth forms. I have ventured the statement that some sixth forms are better than others, from which I suppose it follows that some are worse than others. We are in danger either of assuming in all our students what has been achieved only by some or of gearing our courses to what can be assumed of all.

I venture the hope that we shall in fact continue to gear what we require to the high level of good sixth forms, and that we shall not in fact try in the first year of a university life to provide for an undergraduate student what ought to have been provided at school. I do not think that it is our business to try to be sixth forms, however some of us may think that we could do it better than the sixth forms do however we may be inspired by some good sixth forms to an idea of what one year or two years of sixth-form education can be. It is the business of the schools to be schools, and of sixth forms to be sixth forms, and of our courses to be university courses and not school courses.

The extent to which specialisation in sixth forms in the particular subject or field of study which a student is going to pursue at a university is a desirable thing, and how much importance we should attach to apparently proved specialist performance in one line or other are questions about which there seems to be a good deal of difference of opinion, at any rate amongst my own colleagues and amongst those whom I have consulted in other universities. The schools, I think, naturally suppose that if they can bring their sixth form students up to a high level not of excessive specialisation —nobody ever indulges in excessive specialisation except the people that we dislike—but of reasonable specialisation in a field of study that is what we like

I have myself more than once, at conferences between universities and schools, urged that there should be far more rational attention than hitherto paid to getting school syllabuses and university syllabuses more " end-on " to each other Indeed, an abstract noun, " endonitas " has been used before now I find, however that there are others who take precisely the opposite view I have found some university professors

who say quite cheerfully and apparently with full meaning, that they do not care what specialisation has gone on in the student's past, and they do not care what advanced level subjects have been conquered, provided they are not the one which is going to be taught to the student as his or her honours degree course. It is now becoming in some places almost a disqualification for a student that he or she should have reached advanced or scholarship level in the particular field which he or she proposes to enter for an honours degree. I do not know what is the right answer to that, but I think it is about time that some serious attempt was made to decide where school studies end and where university studies begin, and also to decide whether what I have barbarously termed "endonitas" is a desirable thing or not.

It may be that this is a problem which is more acute in the sciences than it is in the arts or letters faculties, but I am sure that it exists in the letters faculties as well. There is the inevitable tendency and temptation, which I know from the school end, of an able and interested sixth-form master or mistress to get on to the attractive and interesting parts of a subject, whether it is ancient history or one of the sciences or French literature and so often the consequence of their doing so is that the universities complain that these particular students have indeed a superficial acquaintance with some things with which it would be very much better that they should never have become acquainted at all, but that they have no firm foundation on which we in the universities can build. There is a certain amount of odium, if not *theologicum* at any rate *linguisticum* between the schools and universities at that point.

The next point which I wish to suggest is deserving of attention is this issue of specialisation, which I am afraid we have to face, well worn though I am sure many of us think that it has been. I am prepared to be dogmatic enough to say that the most important thing of all for university students, as I understand universities, is that they should learn to go deep somewhere. Precisely where will be determined, of course, by their own interests and abilities, by perhaps, the particular interests of the professors under whose influence they come, and by the principles which the particular study which they take up is intended to illuminate but it does seem to me that it is time that we reasserted—and I am sure that it is necessary to reassert it, if we believe it—that to go deep somewhere and to know something pretty definite and detailed about something is what we should really be up to. I should have thought that from there the specialisation that everybody deplores so much would in fact cure itself by moving outwards in widening circles, if this

central core of interest is one which is properly taught and properly studied

I believe that this is relevant to the question of the over crowding of our syllabuses, because I hear more now than I used to—but that may be accident only—about the temptation which some of my colleagues find difficult to resist to (as the phrase is) cover the ground. I suspect that when we get into the way of thinking and talking in terms of covering the ground, already we are in danger especially if there is anything in what I have been trying to urge about going deep. Of course a course becomes overcrowded if the ground has to be covered, if by that is meant, as I think it often is, that the student is being allowed to regard what I can only call, very barbarously "total coverage" of, for instance, English literature or English history as a desirable thing to try to achieve in three years. I have heard in my conversations on this topic of those who do in fact attempt that and who think that it is the right thing to attempt. I confess that I do not.

The third point on which I want to spend a minute or two is this, that that danger—the danger that inevitably arises if one gets into the way of thinking in terms of "total coverage"—is obviously a greater danger still if the student is required to pursue—I think it will be "pursue" and very little more—two or even three subjects at equal strength, or at hardly varying strength if the ideal behind them is covering the ground. I cannot really exempt my university colleagues from the charge which used to be brought against specialist sixth-form teachers in schools, that if there are three —let us leave it at three—professors, each of whom has claims on a student, the chances are that before very long each of those three will assert claims in sublime indifference to the claims of the other two If that is so, then the student is in for a very fierce time not, I think, a very thin time but a very thick time

That must especially be the case if the student of whom we are thinking is, as from the nature of the case he or she must often be, one who is of, or who is deemed to be of less than the required intellectual calibre to take an honours course in any one subject. I am very much aware that the student who is taking a general degree, whether a general honours degree or a general pass degree, probably has, in sheer weight of stuff to be got through, more to do than the ordinary person reading a final honours school. It may well be that the person doing the pass degree is taking the pass degree because he or she is deemed to be intellectually incapable of the other I am pretty sure from the short experience which I have had in one university lately that it is

very much easier to get a third in most honours schools than to get a general degree

Finally a straight honours degree course properly devoted not to amassing superficial information but going deep somewhere, will, I think give concentration and discipline and the illustration of principles as well as giving at the same time a genuine and firm basis from which to move outwards and onwards to include more and more starting from the specialist starting point. It seems to me that it is our job to promote this outward motion and to expect it of our good students, but not to try to enforce it by what I have presumed to describe in my notes as sticking on extraneous and irrelevant slabs of other studies, and especially it appears, "cultural" ones because if we do that we are in very grave danger of something which I have seen happening in schools, that a subject is now deemed to be "cultural" whatever that means, in direct ratio to its irrelevance to anything else There are a good many schools now where—believe it or not—the reason why Latin is regarded as the cultural subject *par excellence* is that it is not the faintest use to anybody I hope that we shall never get ourselves involved in what seems to me to be the preposterous equation that the irrelevant equals the cultural, if amongst the many meanings of that word "cultural" is to be included that which we hope will be at any rate one of the fruits of a university education.

The CHAIRMAN We are indeed indebted to Mr Wolfenden for his very valuable contribution.

I now have great pleasure in inviting Professor Massey to address the conference.

Professor H S. W MASSEY M.Sc., Ph.D., F.R.S., Quain Professor of Physics, University College, University of London I am going to start off quite unashamedly as a science specialist, and I shall talk about the problem as seen by one who has to teach and arrange for teaching students in science subjects, and particularly physics, although I have had experience also in mathematics. I am going to talk mainly to the notes which I have contributed, with the idea of enlarging them somewhat in various directions, and later I shall consider the problem in a rather wider sense.

Of course, if one confines oneself to science subjects one is still far from specialising, and I want to emphasise the great variety which is encountered within the science faculties themselves in going, for example from mathematics—which for one reason or another is regarded as a science—through physics and chemistry to the biological sciences. The problems are very different, and they exhibit all sorts of difficulties which have to be faced

First of all, you will notice that I have listed in my notes what I regard as important requirements of university undergraduate courses in science subjects. We ought to be clear about this before we consider this whole issue. I have listed as the first of these requirements the realisation of the full cultural value of the subject. In using the adjective "cultural" here at any rate I cannot be accused of regarding "cultural" as associated with irrelevant and useless. The opposite situation usually applies to science: it is regarded as useful, as purely a technique, something which should be confined largely to technological education and as having no real educational value in the full sense. This I always protest very strongly against, because I feel that an appreciation of what science can tell us is of the very greatest general educational importance. No science course succeeds, in my opinion, unless it does convey to the student much of this very important side.

My second point is the need for proper balance between training in principles and technique. This again is closely related to the first point, because we have to think of both sides of a science. There is the cultural side—I shall use the word "cultural" always in its proper sense—and also the more "useful" side. To some extent, though not fully, principles and techniques are associated with these aspects, but in both we have to have something of these two. There is a very different approach necessary in dealing with technique and in dealing with principles, and it is very important that the principles should be to the fore. This again varies from subject to subject, and in physics the problem is in fact somewhat easier because the selection of the principles, the realisation of the principles, is rather more obvious than in some of the other sciences.

When we come to the question of technique, there is the important complication, in considering overloading, that it is often necessary to imbibe very extensive knowledge of technique in order to appreciate principles. This is particularly so in subjects which, while they are the main specialism of the student, do require a considerable acquaintance with other subjects. There is the problem of subsidiary or ancillary subjects with which the student needs to deal, and this can often lead to a very marked increase in the load placed upon him. This is particularly so, for example, in chemistry. A student in chemistry has to know quite a lot of mathematics, quite a lot of physics, and often something of biology as well. If he manages to assimilate what he is supposed to assimilate, he will be the least specialised of all undergraduates.

The next point is proper emphasis on both the

and the practical sides of the subject. In science subjects, as distinct from arts, we have to consider the practical side. I do not mean practical applications, but the fact that science proceeds by a two-way procedure involving developments in both theoretical and practical directions, or perhaps one should say experimental rather than practical directions. It is necessary to consider what emphasis should be put on training in these two sides.

Instead of taking the next point now I should like to take that which I have listed as (*e*) and in this connection to point to the problem which is raised. In (*e*) I have said that there is a need to deal with students whose interests and natural abilities, though appropriate for the subject, are nevertheless rather varied. By that I mean that in order to provide for the different ways in which scientific work proceeds we have to have people whose actual abilities are in a variety of directions. This is perhaps best illustrated by a rather exaggerated description of the three kinds of physicist. It is necessary to have experimental, theoretical and mathematical physicists, and they can be distinguished in rather loose terms as follows. The experimental physicist can measure the value of a physical quantity. He has no idea why he gets the result he obtains, though it is a correct one, and he is quite incapable of calculating the value. The mathematical physicist is able to calculate the value of the physical quantity, but again he has no idea why he gets the result he does, and he has no idea at all how to measure it. The theoretical physicist is quite incapable of obtaining the value of any physical quantity, but on the other hand he does know why the experimental and mathematical physicists get the results which they do. There is in fact a good deal of truth in these distinctions, and you have to select your students accordingly, realising that there are present amongst the good ones those with abilities in these three directions. You have to make sure that you do not damp out one or other of them, because they are all important.

We now come to the very important point of the need for the student to glimpse at some stage in his undergraduate career the present boundaries of the subject. He should do this in order to feel a real sense of proportion in the subject, to realise how far it can go and has gone. This is, of course, one of the major difficulties, because in most of the science subjects—in all of them, in fact—there is so much additional progress into the unknown every year now that to keep glimpsing the horizon poses a very great problem indeed in the choice of subject-matter for the undergraduate.

This need is sharpened by the purely economic problem

that, as the funds go at the moment for postgraduate work, a student is expected to begin research after his three-year undergraduate career is over and it is very difficult to see how he can start to do that at all effectively unless he has some realisation of the boundaries of the subject. It is this particular problem which is one of the most serious, because of the rapid rate of accumulation of new and important knowledge in the science subjects.

This means that when we come to consider the third year of an undergraduate honours course in a science subject there is great difficulty in choosing the subject matter. The Vice-Chancellor of the University of Reading has mentioned in his notes that there are two problems, that of choosing the syllabus and that of whether or not one works to it. In the science subjects the choosing of the syllabus usually does not arise, and the problem is what is actually taught, without relating it to the syllabus as such. To show the difference between this attitude and the attitude in some other faculties, until very recently the syllabus in physics in the University of London consisted of one line, "The principles and technique of physics." One has no guidance there, and indeed it would be very difficult to provide any guidance, but the choice has to be made with all those requirements which I mentioned at the beginning in mind. This is particularly difficult with a rapidly advancing subject.

On top of this there is the very important problem in all the experimental sciences of the time taken up by practical work. This is a very important matter because in most science subjects the time outside lectures which the student has in the day is almost always occupied in practical work. This is something which is quite important and it is not possible to teach science subjects without having an adequate opportunity for practical experience in those three years. It may be that there is a little too much, but the ground to be covered is wide. This is a serious matter in considering overloading.

It is true that in some of the subjects in a science faculty such as mathematics, the question of practical work does not arise, but, as I shall mention later, in mathematics there are other problems, because specialisation in mathematics is far more advanced than in most other subjects, at least so far as the teachers are concerned, and the students usually find that they are given too much to do for other reasons.

Having all this in mind, we should ask ourselves the question: can a satisfactory science course be provided in three years without overloading the student? The answer is probably not. The requirements which I have listed are so severe that even if students entered the university at the same level and with a satisfactory standard of basic knowledge

it would be difficult in three years to bring them up to the necessary level and hope that they would have gained sufficient permanent value from the course The situation is greatly aggravated however by the extremely uneven standard of the students at entrance. This problem is going to be acute, for the science faculty at least, for a long time to come, because of the problem of science teaching.

It is very serious to have boys coming in and becoming students from sixth forms where in subjects such as physics they are supposed to have learnt very important basic principles. In physics particularly the subject of mechanics is one of the most important, and unless it is properly understood it will always be a handicap at all later stages in the student's career and yet in universities a large part of this, in physics at any rate, is taken for granted This means that some students are unduly handicapped by this problem of the very uneven entrance standards.

We should also ask ourselves the question are existing science courses in universities such as to overload students? I do not think there is any doubt that there are many which do overload the students. There is great variation, I am sure, from department to department within the same subject, and from subject to subject. I think that on the whole the situation is not quite so bad in physics, because it is not quite so difficult. There is a rapid advance in physics, but it happens to be the most advanced of the sciences, and that means that there is a highly developed theoretical side of the subject which has a strong synthetic value in making it possible to pull together a great variety of information without the necessity of remembering all the isolated facts. It is possible to see the relations between them, and if they are properly put forward the student is able to assimilate a great deal of material without having to remember all the details.

The situation is less satisfactory in other sciences because of their stage of development. It is particularly difficult in the biological sciences, where a great deal of material is forced into the student without his being able to see the relations between the individual facts. I am sure also that there is a great deal of overloading in mathematics Mathematics is, as I have said the most specialised of all the subjects which come under the science faculties, to a large extent because mathematics has developed so far that there is very great specialisation amongst mathematicians, and at an advanced level a mathematician in one specialism finds that it is very difficult to understand one in another The result is that in a university staff where it is necessary to have representatives of all these specialisms, each one is anxious that the student should be given a sufficient training in his particular special

ism, and accordingly the syllabuses are heavily overloaded in many cases. I may appear to be a little dogmatic, but I hope that all those who feel that their mathematics courses and science courses are not overloaded will take part in the discussion and say so

The next question is Can we improve this situation? So far as science is concerned I think that something can be done by emphasizing to the maximum the principles of the subject, trying to bring them out clearly so far as possible—this is much easier in physics, as I have said, than in other subjects—so that the students do not have to assimilate great numbers of facts which are comparatively unrelated.

I think that the three-year period for the undergraduate course will have to stay for some time for purely economic reasons. It is not possible to change the whole system of grants for postgraduate work and for undergraduate work so that there is a longer period than three years for the undergraduate course I think that something can be done by relaxing the idea that after three years the undergraduate becomes a graduate and therefore will normally cease to learn, except during his research work. I find that research students take this attitude to a very considerable extent, that having done their three year course they can now start to do research and need not bother about anything except the particular thing on which they are working. I feel that we have to change this situation quite drastically

We cannot do this by supposing that they are going to take more than three years before they start doing research without having to change the system of grant-giving throughout the country but there is no reason at all why students who are undertaking a Ph.D course should not have to learn and understand more, apart from the particular specialist problem on which they are engaged This is a direction in which I feel that we could make substantial progress. It is true that the requirements for the Ph.D provide that the student shall know the background of his subject, but this is interpreted very variously and is usually taken to mean only quite a narrow background. I feel that there should be more scope for ensuring that after three years, although the student does undertake research work, he should at the same time learn and understand more about his subject.

So far as the school problem is concerned in science there is going to be difficulty for a long time to come. I disagree on this matter with Mr Wolfenden, in that I prefer when students undertake science courses at the university particularly in subjects such as physics where the basic principles are so very important, that there should be an attempt to start from the beginning, but not going over the ground in

the same way and attempting not at all a sixth-form approach but a university teaching approach. If you start from the beginning you can establish the principles more soundly and if you do that half the battle is won because an understanding of the principles is the most important thing of all

In my concluding remarks I should like to say something about other faculties, because this problem is obviously not confined to arts and science. Although my knowledge of other faculties is slight, I nevertheless have some views about them. My feeling is that in the professional faculties—I exclude law about which I know absolutely nothing—there is possibly more overloading than in either arts or science. This is probably due to too much emphasis on technique and too little on general principles. I feel that this is a general difficulty that in order to meet professional requirements there is a tendency to force in facts and technique without any attempt to systematise and put forward clearly to the students the principles involved I also think that in the technological faculties insufficient attention is paid to developing those differing characteristics, all of which are desirable in the full practice of the profession. In engineering, just as in physics, we require different kinds of ability in order to have an adequate and thorough engineering profession in the country but insufficient attention is paid to developing these sides with the result that a student whose bent is rather more towards one side or the other does tend to find himself overloaded, because of the uncongenial character of so much of the work that he has to do

Despite all this one of the things which I am very surprised about is that students in the professional faculties often make greater contributions to university activities than students in arts and science. I would further say that while it is true that students are very narrow in their knowledge of cultural activities, it is usually true that on the average the science or technological student has more knowledge of the arts than the arts student has of science I end by asking the question Is it possible that the arts student is rather more overloaded than the others?

The CHAIRMAN I am sure you will agree with me when I say how illuminating Professor Massey s survey of the position with regard to the sciences has proved to be, and how much we welcome his practical suggestions. Before we begin the general discussion I should like to welcome once again our guests and in particular our colleagues from the Commonwealth and America, and to inform them that their contributions to the discussion will be gladly received. If speakers can

limit themselves to five minutes it will be a great help to the Chair

Dr D H. Peacock (*Sheffield*) I should like to say a word or two about the question of culture. Culture is, of course, related to cultivation, and we want to ask ourselves what it is that we are cultivating at a university Are we cultivating the student or are we cultivating the subject? The answer of course is that we are endeavouring, with a greater or less measure of success, to cultivate both. I suggest, however that from many points of view probably the slightly more important task—and I emphasise the word " slightly "—is the cultivation of the student, because although the majority at any rate of science students, when they leave the university continue to prosecute the subject which they have been studying, even amongst the science students there is a minority and not by any means an insignificant minority who change over from that subject to something quite different. From their point of view of the education or cultivation which they obtain at the university probably the more important part is the cultivation of their own minds.

That leads me to support the claim which has been made by both the principal speakers, that the more important part of our task at the university is to cultivate the principles of the subject. In parenthesis I should like to point out, in connection with this metaphor of cultivation, that amongst horticulturists there is considerable argument about whether deep cultivation is advisable or not. I do not think that we can prosecute the analogy too closely on those lines, but I am sure that it is possible to cultivate the principles of a subject in such a way as to give the average student in three years an adequate grounding in those principles, and an adequate knowledge of the application of those principles for his further work.

I should like very strongly to support Professor Massey's remarks about the nature of postgraduate research work. It is perhaps deplorable—I might even say lamentable—that when the universities of this country took over the Ph.D from the continental universities they did not more completely imitate the courses of study I suppose that we in England thought that our undergraduate courses were so very superior to the undergraduate courses of continental universities that there was no necessity for the student who was going on to take a Ph.D to take any further course in his work Those of you who are familiar with the old courses for the Ph D in the German universities, both on the arts side and on the science side, will remember that it was quite common for a student who was writing his thesis to go to his professor and

discuss the thesis and be told "Well, Mr So-and-so I think it would be an excellent thing for you, before you write your thesis to attend Professor So-and-so's course on X Y or Z."

In the universities of this country very little of that is done, and very little is done in the way of postgraduate courses. I think that by the introduction of postgraduate courses we could do a good deal to fill up the inevitable gaps. I say "inevitable" because nobody in three years can cover the whole subject matter of any science subject.

Dr G N Burkhardt (*Manchester*) I speak as a chemist and as senior tutor to a faculty of science There is general agreement that the sciences are progressing so rapidly that they present some problem for the students, and it is worth while examining from time to time the final papers over the various decades to see what has, in fact, happened. This may be helpful in considering what sort of treatment is necessary and if people would do it more widely we might get some more specific attack on these problems.

In the case of chemistry if you show a modern group of undergraduates a pre 1914 set of final honours papers, they laugh, not because the subject-matter is out of date, but because they covered such a large fraction of it at school I would say that in such papers in the early 'twenties the content and the difficulty of the conceptions involved—both of which are important—were certainly not much greater than those required for a modern ordinary degree. The change from the early 'thirties onwards has not been so great but there has been in chemistry the increase of range which Professor Massey mentioned, so that the subject now runs into biochemistry on the one hand, and mathematical physics on the other and I would say that there has been an increase also in difficulty I agree with Professor Massey that the comprehensiveness of the conceptions is greater but I feel that he underestimates the problem which this presents. The implication of his remarks, that thermodynamics, quantum mechanics and relativity are matters which can be quickly grasped and rapidly applied, seems to me to be false. The modern approach is much more stimulating, and ultimately much sounder as an educational process, but it is not easy

This change has not taken place in the universities alone A considerable amount has been done in the schools partly through improved teaching, partly through increased specialisation with a good deal of increase of pressure. The question is how does what we are requiring of a student of 21 compare with what was in the past required of a student of 21 and are we justified in accepting the present situation?

On treatment of the problem—and I am sure that it is a

problem in science, and a greater one in medicine and technology—I agree with Professor Massey that we cannot at present contemplate a course of four years, unless we are driven to it because the schools cannot lay a foundation, in consequence of the shortage of teachers which we discussed yesterday I am sure that he is right in saying that the aim should be to continue the education of selected people, a higher proportion of selected people than at present, in the fourth and subsequent years, after the bachelor's degree.

I notice, incidentally that Professor Massey like a good many other people, seemed to be thinking almost entirely of the man who was going on to do research. If we accept the idea that we must be careful about our requirements at the bachelor level, and supplement them in suitable ways for selected people later there are a number of possibilities. There is the possibility of postgraduate research, and also the possibility of courses in applied science, chemical engineering, as a postgraduate study and a variety of other things. I am sure that that is one line which should be watched most carefully

We ought, also to consider more fully the development of ordinary degree courses The nomenclature for degrees is very confusing The term "honours" has two quite different meanings. In some cases it is what seems to be a redundant addition to first class and top second class, whatever the course may be. In the term "honours school" it refers to a particular type of discipline, a discipline designed essentially for the education of scholars In the sciences, that means for the education of research workers on the lines which Professor Massey has described.

The nomenclature could be rationalised a little if the ordinary degree course were regarded as designed for the education of the commoner and my feeling is that we ought to attend much more seriously to the education of the commoner By "commoner" I do not mean a person who has not a scholarship, but I wish to distinguish between the real scholarly qualities and the commoner qualities of good ability substantial intellectual interests and other qualities which are much wider as well.

I am glad that Professor Massey emphasised that honours degrees in general science are the most severe proposition in a university That is certainly true. I believe that they can be made most satisfactory if it is accepted that the breadth shall be at a modest level, and that they shall have the depth, to which Mr Wolfenden referred, in some part of the field, preferably on the borderline between two main subjects. I am responsible for those people in my own university and I

am staggered by the freshness of mind which the good ones retain

On the other side there is one point which refers back to a previous discussion. I am sure that in many universities at the present time students are making the overloading of courses far worse for themselves than they need because they will not think in terms of a full day a full week and a full year for the great variety of their student activities. The problem of encouraging them to use vacations satisfactorily is one of the first importance. On the question of the increased range of principle, the great thing that is needed is time to digest the principles and understand how to apply them, so that high pressure attention during the term is by no means adequate

There is one administrative matter here to which we are giving some attention Where there is an examination at the end of each year this tends to make students, quite unreasonably say "Now I have dealt with that. What do I do next?" They ought, of course, to be able to find the answer but they need help on the positive side to decide on what subject matter and by what methods they can profitably use vacations.

Professor N FEATHER (*Edinburgh*) I should like to take a remark from each of the opening speakers and set them in opposition. Mr Wolfenden said—and I agree with him—that at some stage in the course the undergraduate should go deeply into his subject, and Professor Massey said that at some time he should glimpse the boundaries of it. In my view these two remarks, both of which I regard as self evidently true are not necessarily antonymous. I think that it is very possible to go deeply in some place in the first year

Teaching in a Scottish university I already have the situation which Professor Massey said was not likely to be attained if it was even desirable, in England in the immediate future, namely the situation of having undergraduates for four years for a science course The first year is more nearly at the sixth-form level than it is in the English universities, but I find that even in the first year at a Scottish university it is possible in a subject such as physics to go deeply occasionally

I think that it is very important indeed, when the young person comes from school to the university to startle him at the outset by taking him deeply now and again, because the question of depth here is not necessarily a matter of being recondite but of putting before a mind which is capable of appreciating it a novel fundamental idea, which is surely the main object of bringing a man or woman to a university to give him or her a broad education I would say therefore,

that this matter of depth need not be reserved for the final honours year

Maintaining that position, however carries with it an implication which is perhaps more difficult to accept and follow It is surely that if one deals in this way with a science course in the first year one requires of the student, as one normally requires of students in an arts subject, reading over and above what he gets in lectures and practical work. There has been a tendency to think that it is natural to require such reading of the arts student, but improper to require it of the science student, because he has not the time for it, but I feel that it must be required of him if this approach, which I regard as the correct approach, is to be followed in detail, and there, of course, we do come closely to grips with the question before us of whether or not the course is overloaded.

Dr L. ARNAUD REID (*Association of University Teachers*) When I came here this morning I did not mean to speak, but, having listened with very great interest to what has been said, I would mention something which has not, I think, been referred to so far Mr Wolfenden spoke about depth and breadth and the kind of education which can be had in the sixth form, and I do very much agree that very often one s own education is something which develops outwards from a basic interest.

I am a philosopher by training, and was a straight professor of philosophy before I came to London, when I became a professor of the philosophy of education I have on a Friday morning to lecture to six or seven hundred students in this very room I am very much concerned with this matter We get in education the products of sixth forms and the products of the university It seems to me that one aspect of this depth which has been spoken of can be called philosophy by which I do not necessarily mean having set courses in philosophy but having guided discussion of the implications and assumptions of any subject and its bearings on other things. It is very hard to do this well, and I think that in sixth forms it is very often not done because sixth form teachers themselves, being products of English education—in Scotland it is a little different—have no " philosophy " at all.

Philosophy is taught to a minute fraction of the university students who are specialists in other fields. We see the lamentable effects of this when they begin to try to think about education.

We have university graduates who themselves are well trained, very often, in their own fields, but who when they come here say " We have never in our lives before thought about the nature of our subject and its relations to other

things." We have scientists who have never thought about any questions of the philosophy of science historians who have never thought of the nature of history and so on, and we find this kind of thing a very great obstacle to our work.

We try here to give them something which they do not get in other places, but we find it hard because any fundamental thinking outside their own field is so new to them. They get it certainly here and there but some of our students complain very much of this lack in their previous education. I agree with what Mr Wolfenden said about "little bits" of added information about other things I do not want that, but what I should like to see, far more than it is seen now in universities is that philosophers (professors and lecturers) should attend to those who are specialists in other subjects, and vice versa. I should like the scientists and the arts people and the philosophers to meet and to find out the ways in which they can help one another and the students on underlying problems, because I think that it is one very important way in which the depth and breadth of education can be secured

This is not a plea for more specialists in highly technical philosophy but rather for showing how the philosophical habit of mind is important, in the first place in the universities, and in the second place going down to the schools, for those who are concerned about their own subject and want to see its relations to other things, and who perhaps also want to ask themselves the questions which young people ought to ask themselves about life and freedom, and faith and death, and man and God—in fact, the great eternal issues. In the universities in these days, unfortunately these things are crowded out. I do not think that very much can be done by having special courses but I am sure that a good deal more could be done if those who are concerned about these things would get together and find out what the living interests of the students are and how they could be helped in their thinking about basic questions

Professor F H. NEWARK (*Queen's Belfast*) There is no doubt that the undergraduate courses of the present day are overloaded and the reason is not far to seek. The situation in its simplest terms is that by graduation day the student must have amassed a certain amount of information, and this by tradition is a task which is distributed between the school and the university As the boundaries of knowledge extend, obviously there has to be some reorientation of the teaching.

We will assume that the universities have that matter in hand let us inquire how the schools have dealt with it. The first thing which appeared to the schools to be right was to ensure that those students whom they were sending up to the

universities had a more adequate ground-work in the degree subjects which they were proposing to study Immediately there was an outcry of "narrow specialisation" though I have never discovered what the epithet "narrow" adds to the word "specialisation" At any rate the universities made that charge, and the schools, not unnaturally thought that they were doing something wrong and had better make amends. Sometimes they have made amends in the way in which the Vice-Chancellor of Reading mentioned, by throwing in courses in direct contrast to the main subject, giving a little extra Latin to the scientist, and so on. Sometimes they have con cluded that the best way in which they can assist is by performing part of the function which is usually assigned to the university—by giving a certain breadth to the man's intellect—and this they have tackled by including courses in contemporary affairs international affairs, appreciation of beauty and whatnot.

This is something which the schools are singularly ill-equipped to do In the first place, it is only rarely that they have anybody on the staff who is competent to do this. A public-school teacher told me once, that though he is quite prepared in the staff common room to read the *Daily Telegraph* and the *Sunday Times* he would not dare to read the *New Statesman* because immediately he would be regarded as somebody capable of seeing both sides of a question and put on to teaching contemporary affairs.

The result is that the fresher who comes to the university comes with a few narrow specialist facts rattling round in his head, and the interstices filled with vague and woolly ideas on culture which have been given him in the sixth form. It is not surprising, therefore, that the majority of university teachers feel it unsafe to make any assumptions about the quality of the freshman which they have.

Obviously what is needed is something in the nature of what the Vice-Chancellor of Reading called "endonitas"—that is, some splicing of university and school work. The only difficulty that I see about that is that it is not sufficient merely to have a splicing of one paper syllabus to the other because the university teacher is dealing with students who come from a variety of schools, schools with different facilities, and schools with teachers of different capacities. You will be aware of the multitude of hands which "a strong no trump" can cover It is never safe to make assumptions, and therefore you will find that in the universities, when these freshers come up, the members of the staff feel that it is not safe simply to rely on such statements as "I took my three advanced subjects and then spent two years in the sixth form doing modern history" It is not possible to build anything on that.

the teacher feels himself responsible for the whole bag of tricks—ground work, foundation and super-structure. The inevitable result is that the course is overcrowded.

Professor R. E. PEIERLS (*Birmingham*) I would claim that the content of most university courses is not overloaded, at any rate in all the cases with which I am reasonably familiar and I would not exclude the courses for medical students and engineers. Although it is very often said that they are terribly overburdened I do not believe that they contain more than can be taught to normally-equipped students in the time available. I have, however met many cases where students are overloaded, and I think that there are three reasons for this when it happens. The first is that, as has already been mentioned they may have the wrong approach to their subject, in that they approach it with the aim of memorising all the detailed knowledge which is available rather than seeking an understanding of the principles. That may be the fault of the student, or of the teaching, or of the school from which the student came. This wrong attitude is very often aggravated by the fact that there are some students who come to the university because it seems to them the natural thing to do, and have never got a realisation of why they are doing it or become interested in their subject. If you try to read a book without being interested, so that unless you concentrate very hard you forget what is on page 15 by the time you get to page 16 it takes a very long time to read the book

The second reason is that students are trying to do a little more than they really can. The student of second-class honours calibre is trying by all means to get a first or it may be that he is a first-class man but thinks of himself as second class and believes that to have the chance of a research career or whatever it is he wants, he has to work twice as hard to learn just a little more If we could get it into the heads of our students that they are at the university primarily to learn the understanding and use of their subject, and that if they do that they will find their own level in the examination, it would help to keep down the pressure which they feel at present.

The third reason is one which has been already referred to It is that so many students do not make, have never learnt to make and cannot be persuaded to make an efficient use of their time They waste an awful lot of time either on unnecessary things—things which are necessary neither for their university course nor for reasonable enjoyment of their time at the university—or more often, and what is still worse, they waste their time completely When I travel to other countries and watch the activities of students there often in very difficult

economic conditions, and often having to earn a living besides attending a university and still being keenly interested in their subject and their course—I think that this applies to almost all other countries the position is perhaps different in the undergraduate courses in the United States, but not in the postgraduate courses—I feel ashamed for the majority of our students who claim that they have too much to do.

A few weeks ago a student came to me and said that he would probably do very badly in the examination, although he had been warned that he was a borderline case. He said, "I could not do more, because the activities in connection with the university carnival and my work for the university dramatic society took so much of my time that I had none left in which to do my studies." I believe therefore, that if we want to get away from the pressure which many students do feel, it is these facts which need attention.

While we should not think of reducing the amount of understanding, and certainly not the level of understanding, which we are trying to reach, I agree with Professor Massey and others that the postgraduate teaching needs a great deal of attention. I should like to add that we should here think not merely of the Ph D student, because for this purpose the master's degree can be extremely useful for those who do not want to specialise in research. For scientists who want a job in industry an extra year spent for the master's degree, doing perhaps a little simple research problem or attending postgraduate courses only can often be a much more valuable preparation. If this is adopted, it may happen that after some years people will prefer the master's degree to the bachelor's degree in the way in which they now prefer the honours graduate to the man with the ordinary degree, and our university course for such purposes will thus be lengthened to four years.

Professor F S. DAINTON (*Leeds*) I was very interested in Dr Burkhardt's comments concerning degree courses in chemistry I would like to emphasise the view that, as a subject advances and the principles involved become clearer it should be possible to discard from the course increasing amounts of detailed memory work. When this pruning has been done the total volume of knowledge which we require of our three year course students is not in my view excessive and is not appreciably different in quantity from pre-war requirements. If this view is correct it raises the question as to whether we are now discussing the overburdening of the contemporary undergraduate because a larger proportion of undergraduates are less able to tackle their courses successfully than was previously the case Do we not have to

recognise that we have doubled the number of science students in our universities and that it is a common experience that in so doing we have increased the proportion of less able students?

My own experience illustrates the effects of this dilution. First year courses in physical chemistry which *pace* Professor Massey are largely concerned with principles of chemical physics and which would have stimulated the majority of a pre-war freshman chemistry class, in fact now stimulate a very small section of the contemporary freshman class and successfully anæsthetise the remainder I think we have to realise that, with this greater range of ability we must be prepared to take our first year students and classify them into at least two groups those capable of what may be called a rapid three-year course, and those capable of getting through the same amount of material at a rather reduced rate, the first year being much more in the nature of an "end-on" course to that of the school making the transition from the school attitude towards the subject to the university attitude a little less abrupt. I feel that that is an extremely important point.

The proper use of the vacations has been mentioned, and in this connection I would like to say that I believe it is the university teacher's duty to make quite plain to the undergraduate that the student's calendar year is divided for the sake of convenience only into 24-30 weeks of formal teaching and laboratory work, and 28-22 weeks, formally referred to as vacation, which, apart from time spent in recreation, are for reflection, further reading, and the private effort essential for a proper understanding of one's subject. A device, worthy of wider application, which encourages this desirable student attitude is the end-of vacation rather than end-of-term or end-of-session examination.

My third point concerns postgraduate courses, about which we have a great deal to learn from N American, and particularly United States, current practice. Whilst I believe that it is largely true—this is a piece of personal dogma—that to put a man in a laboratory with seven feet of bench space and a number of test tubes for three years, and to ask him to work on a small problem, is about the most educative process to which we can subject him, I am also convinced that it is necessary for us to encourage wider development of the outlook of research students by instituting postgraduate course work. This applies both to those preparing for masterships and to those preparing for doctorates, but the emphasis should be different. The candidate for a master's degree should be regarded as being in training, and any results achieved during the research part of the training should be considered to be a desirable consequence, but secondary to the primary purpose

of training. For the would-be Ph.D the emphasis might be reversed. In either event the increasing numbers of bachelors going forward to research degrees and therefore receiving some formal postgraduate training should make it possible to restrict to desirable limits the inflation of the matter presented in the undergraduate courses

Dr G B. JEFFERY (*London*) My medical friends have often tried to explain to me the doctrine of clinical responsibility and my understanding has gone to this point, that I can see that the condition of a patient often presents problems which require for their proper consideration half a dozen top-ranking experts, but it would not be the best way of meeting that situation for the patient to be trundled round from one ward to the next, so that everybody could have a go at him for a couple of hours and then pass him on. Neither would it be an adequate solution to the problem for all these experts to have their say to the patient, and for the patient himself to decide the right balance. If either of these things happened the patient would be dead before the end of the day

It seems to me, however that exactly that sort of thing is happening with the majority of our undergraduates today and as a result they are intellectually dead before the end of their courses. There seems in most circumstances to be nobody or hardly anybody surviving with this kind of overall clinical responsibility for the planning of the course of the individual student. I know that undergraduates do receive a great deal of help from many persons in their universities, and help outside the field of their normal studies but, if we are going to have the kind of thing that Mr Wolfenden has outlined some measure of planning seems to be absolutely necessary

I would wholeheartedly support his statement that every undergraduate course of study should go deeply somewhere, and I would add to that the point which I think that Dr Arnaud Reid was making, that the student should not leave his undergraduate studies without at least some conception of the part which is played in a wider area of human knowledge by this little field of knowledge in which he has gone deeply

If these two things are to be balanced in the infinite variety of possible studies in a university and with the infinite variety of individual abilities, somebody somewhere has to take the responsibility for this. It is an old university tradition that this kind of responsibility should be carried. It is still surviving in the university which must take the blame for Mr Wolfenden, but for some reason or other it seems progressively to be destroyed as university teaching, mainly on its scientific side,

becomes more and more a question of large departments and highly-organised laboratories. That kind of thing seems inevitably to kill this individual tutorial responsibility for the student and so we have arrived at a state of affairs where if it is considered a good thing that Professor Massey's students of physics should know some chemistry the prescription and the dosage of chemistry will be prepared by the chemists and his students will get what is good for them In the same way if it is a good thing that they should know some mathematics, the dosage will be prescribed by the mathematicians. With the best will in the world it is very seldom certainly on the scientific side of the university that there is any opportunity for one mind the mind of one scholar to plan and to assist the student to plan his work in such a way that he does go deeply somewhere, and that he knows the significance of that into which he goes deeply

As I have used a medical analogy I should like to say that there is no department of the university more critical of the things which I have criticised than the faculty of medicine.

The CHAIRMAN I wonder whether at this point one of our visitors from America would care to give his impression of the position in the U.S A.?

Professor A. N CHRISTENSEN (*University of Minnesota, Visiting Fulbright Professor University College of Wales Aberystwyth*) I wish to say at the outset that I feel very much at home listening to this discussion of university matters. We in the United States have been concerned with these same questions ever since our first college opened its doors in 1636

I feel woefully unprepared to say anything pertinent to the question we are now discussing, namely "Is the course of study overloaded?" My uncertainty is due to several causes, among them are the very large number of universities and colleges in the United States, the varying degree of selectivity in the admission of students to these well over one thousand institutions, and the differing and often directly opposed views on what the function of the university is or ought to be.

If John Dewey were here to answer the question, "Is the course of study overloaded?" he would answer I am sure, "Certainly not," and in giving his answer he would be thinking of the typical American college in which the proliferation of courses is far greater than it is in a British university Robert Hutchins, formerly President of the University of Chicago would say that the course of study is far too over loaded in fact, he said that in Britain just a few weeks ago. If Teachers College of Columbia University were to concern

itself with the question, I suspect that a committee would be appointed, and that when the report of this committee came in a new course would be initiated in order to secure additional data. Finally if former President Eliot of Harvard University who generally is praised or blamed for starting the so-called "free elective" system, were here, I believe he would answer the question with, "I just do not know"

I think it important to emphasise the different nature of the American university and what it tries to do In the first place, our secondary or high schools are much less selective than yours, and intentionally so. Attendance at high school is now almost universal with us. Flowing from this our universities are also less selective—also intentionally so. Our university courses are usually four year courses and not three I believe that it is not until you reach the graduate school level that valid comparisons can be made.

There is running through our whole approach to higher education in the United States the conviction, based on that intricate complex of historical, social geographic and many other factors, that many persons who are intellectually not of the superior or even high average groups can benefit by going to the university and that society can and does benefit from their attendance In general, I agree with this view, but, as you will readily see, it means that we have a differing view of what the university should do and hence what courses it should offer to its students

I am afraid that this is all I can say relating to the answer of the United States to the question we have raised this morning.

Professor D M MacKinnon (*Aberdeen*) There is one problem which I do not think has been mentioned this morning, but which is certainly relevant to a definition of this notion of an overloaded curriculum. It is the problem, of which we are very conscious in the philosophy department at Aberdeen, of the joint honours school In Scotland we have as the foundation of all things the ordinary degree. (I am talking about the faculty of arts.) In the faculty of arts it is the ordinary degree which is the foundation, and I think that any ordinary M.A. student who complained of being over loaded would probably have the same grounds as those of the young man who came to see Professor Peierls. Where the joint honours schools are concerned, however the matter is rather different.

There are in Aberdeen three joint honours schools in which philosophy plays a part philosophy-psychology philosophy-English, and philosophy-politics. The last two in particular attract very good men but there is no doubt that they find it

a strain at the level of honours work, working under and for three different and independent departments the department of logic, the department of moral philosophy and the department of English or politics, as the case may be. They have the feeling that a great many people are getting at them and this is accentuated psychologically by the fact that they are comparatively few in number

A good deal of this may be simple illusion on the part of the student but it is an illusion which can get in the way of effective work, and I know that it has done so in the case of some good students. It has seemed to us, therefore, to be absolutely essential that there should be the closest possible co-operation and integration between those who are administering these courses. If that is achieved the thing can be managed, and actually I think, the students themselves come to see that what they considered overloading is really something else, something less tangible and less easily defined, but still something which has got in the way of their work.

Professor G W PICKERING (*University Grants Committee*) Are undergraduate courses of study overloaded? I suppose that the answer to this question depends, at least in part, on what we suppose that the universities are trying to do. I should like to suggest that their contribution to the community should be that they turn out leaders of thought in their particular spheres. Therefore they are to some extent to be judged by the extent to which their products are capable of independent mental processes at a fairly high level. When I was an undergraduate at Cambridge, some of my friends who were on the arts side used to draw a distinction between education and instruction, and they pointed out that the true function of the university was to carry out education which meant that the student at least learnt partly for himself by his own efforts. One of the essential requisites of education is that the student shall have time and leisure, just as a rather nice letter in *The Times* this morning points out that if students at institutes of technology are going to secure a general education, they must be allowed a little time in which to secure it.

Judged by this standard, nearly all university courses in medicine are grossly overloaded. I would say the same about most, or perhaps all, university courses in technology and I think that the same is probably true of most university courses in science. It may be true that at the older universities the arts students still have enough leisure to become educated

This is a matter of some importance at the present time, when mankind has been equipped with such dangerous toys.

Why are the university courses overloaded? The first cause

is the growth of knowledge, but we are a little apt to forget that knowledge continues to grow after the student leaves the university In other words, it is equally important that the student should leave the university knowing how to learn. I would suggest, therefore, that the first remedy is to put up in a prominent place, perhaps in the senate room of the university this dictum of Karl Pearson s that the true aim of the teacher should be to impart an appreciation of method rather than a knowledge of facts.

The second reason is the fragmentation of knowledge. As has already been mentioned, the medical curriculum leads easily in overcrowding. That is partly due to the fragmentation of knowledge and to the multiplication of professors, as Mr Wolfenden said, because each professor likes to teach his *students as much of his subject as he can, and he also requires* that his new subject shall have a special part in the examination through which the students have to pass, so that a new hoop is provided through which every student must jump. I suggest, therefore, as my second remedy for this overcrowding of the curriculum, that a society should be founded for the protection of students from the multiplication of professors.

Dr K. W SYKES (*Wales*) There seems to be agreement amongst those present that some form of postgraduate instruction is desirable in a science subject if the undergraduate course is not to be unduly overloaded Indeed some of the representatives of larger university institutions have referred to such courses already in existence. It is unfortunately a fact, however that in some of the smaller and more scattered university institutions in this country the staff is already spending enough, if not too much, time on the normal instruction of the undergraduates. I hope that this is not an inappropriate point to make in a gathering which includes many distinguished representatives of those responsible for the more general aspects of university policy

The CHAIRMAN The time for drawing this interesting discussion to a close is very near There is time, however for one or two further speeches, if there is anyone present who feels an irresistible urge to address us.

Miss J BLOXHAM (*Leeds*) I feel not an irresistible urge but a sense of duty It is part of my duty to pick up a number of dropped stitches, and this almost monopolises my time at some seasons of the year There are some groups of students that I find it very difficult to help, and I feel that it is the curriculum which is my enemy There is the student who, perhaps through past history is deficient in some requirement

for the academic content of the course. Particularly in the science faculty I am often unable to find for that student the necessary time to give to tackling her problems in the univer sity term, when she has available to herself the personnel in her department and, for an arts student, in the library

The second type of student for whom I am often at a loss to suggest how the problem should be tackled is the border line case for higher honours a student feels extended in meeting the requirements of the curriculum and does not see her way to exploring what lies between her and a first-class degree.

I feel that it may be true that the curriculum is satisfactory for the average student with no problem either of how to fill in a gap or of how to rise to a higher standard of scholarship, but there are I submit, those two classes of student for whom the curriculum on the whole is not sufficiently elastic to allow for private studies.

Mr B A Edwards (*London*) I feel that it is quite impracticable to generalise at all on this topic. I am thinking at the moment of one particular degree subject in the University of London for which new regulations were introduced recently and of the deplorable result that for the first generation of students it was necessary to go into reverse and alter the construction of the whole degree. At the other extreme we have the new general degree, and the students there have a certain amount of spare time to think during the period of their undergraduate studies.

We ought to consider carefully whether the students are giving themselves too much to do owing to the way in which union and other activities have increased in recent years. It has now become a question of whether a man shall accept office in the union society or shall continue to hope for a good honours degree. So much is this the case that I understand that the Union of Students is suggesting to the Ministry of Labour that the holding of high office should permit the extension of defer ment for one year beyond the normal period

I would also emphasise that more should be done to get students to read outside the syllabus, particularly in the history and philosophy of their subject. We have heard of the possibility of teachers being interested in some aspects of their subject and carrying on research after leaving college. I feel that there are possibilities in the history and philosophy of science, and it might be possible for students to retain their interest in research even after they have gone to a school to teach, and to keep their interest in the subject green during their teaching career

Mr J F WOLFENDEN in replying to the discussion, said There are only two points on which I should like to say a few words, picking them out from the many extremely valuable and interesting contributions which have been made this morning. I should first like to say a word about what is, in my opinion, the extremely important suggestion made by Professor Arnaud Reid and referred to later by Dr Jeffery and others. I may be doing an injustice to Professor Arnaud Reid by trying to paraphrase very briefly what I understood him to say but I understood him to mean that the ability to see where in the whole pattern a particular bit fits is one of those abilities without which a good student ought not to leave the university

The precise point at which this synoptic attitude is first brought to light or inculcated or encouraged in the course of a student's life is clearly a very difficult question to answer I must confess that I can imagine the horror which this will cause in some minds, but, having tried to do almost exactly this with sixth forms in schools over a period of about fifteen years, I know that the reason why that causes horror is an obvious and natural one. "What is the good" I am asked, "of trying to give a philosophical and synopic attitude to youngsters who, by the nature of the case, cannot yet have any valid knowledge or experience to fit into a pattern?" There is some strength in that objection, but, if it is pressed too hard I should like to ask when this synoptic or philosophical attitude is going to begin, because from what we have heard this morning I have the impression that some of the students about whom we have been talking are not a great deal more mature or experienced or knowledgeable than a good many boys and girls not only in sixth forms, but a good deal lower down than that.

If we were to be very honest, which in this room we can never afford to be, a good many of us would say that a certain number of our colleagues who are in their first two or three years of the high office of colleagueship are not really all that much more mature than some of the students whom they as well as we, are teaching. I find, as I am sure that you do that the older we get in years the more stingy we are in permitting the adjectives which relate to maturity to be given to anybody younger than ourselves. I have the awkward feeling that if we are not careful we shall rule out in the schools this business of trying to get a philosophic or synoptic or mature approach, and we shall say that "there is no time for it in the undergraduate years" and "what are undergraduates except overgrown schoolboys and schoolgirls?" Is there a possibility that after the end of the normal degree course is the right time? Or is it too much to hope that, not as an

extraneously slabbed-on course but as an attitude in the teacher by whom we hope that the learner may be infected this notion should go on all through the course, and not only in the university but at school as well? I am certain from one or two experiments and some experience, that it cannot be done by external compulsory adhesion but only from inside, by the teacher

My second point, very briefly is this I did venture to ask about the end-on nature of school and university courses, and I must say that I was a little frightened—though I can well understand the reasons for it—by Professor Newark s comment, which was I think, reinforced by one or two others, about the consequence of our receiving students from such a great variety of schools. I know that to be true and I know the difficulties which it creates but I should like to call attention once more to the danger which immediately arises if we take the line of saying, "They come from such a great variety of schools and their standards are so different that we must assume nothing." Is not that almost the same as saying, "We must go back to the beginning and try to teach them the whole lot in the next three years"? If we do that we shall have overcrowded syllabuses, but we shall have something worse than that. If we say that we must assume nothing and must go back to the beginning, a good school will ask "What is the use of our trying in our sixth form if the universities say that we have taught our people nothing, or if they assume that that is so? All that we are trying to do in our sixth forms will go for nothing" Very soon the schools will, from disgruntlement or disappointment, become a little less eager and enthusiastic about their sixth-form year and their standards will go down, and then, as a result of our action in saying that we must assume nothing, we shall reach the point where we shall indeed not be able to assume anything, because all those who arrive, whether from good schools or bad, will have worked up to but not a whit beyond the minimum requirements which we lay down. I cannot believe that that would really be a good thing for university studies.

The CHAIRMAN I now invite Professor Massey to give us his conclusions.

Professor H S W MASSEY It is a little difficult for me to state my conclusions, but they are, in fact, exactly the same as when I spoke earlier There are however a few remarks which I should like to make in order to clarify certain aspects of the discussion.

The question of the attitude of students has been raised and this is of course, a very important matter I think it is

true that the situation has been more difficult since the war because of the rather greater dilution. There has not been a substantial increase amongst the first-class students, but there has been an overall increase in numbers which leads to dilution, and that is the source of the difficult problem of having to face a class with very uneven natural ability. It may well be that, as one speaker suggested, we shall have to consider breaking up the courses which are provided into different categories, in order to deal with students whose possible attainments vary substantially.

The attitude of the students is often, even in honours subjects unsatisfactory. They are not receptive. They will never try to see the subject as a whole or realise that there are other things which they are required to do and that their subsidiary subjects are given to them for some reason. I have found this in the University of London in physics. The students are forced to sit for an examination on their first year subsidiary mathematics, and they have also to attend a second year course in mathematics with no examination. It is no exaggeration to say that when attendance at that second year course is all that is involved they get absolutely nothing out of it, apart from a very few at the top. In order to meet this situation, I have been forced to institute a local examination and to threaten that account will be taken of their performance in this in giving them testimonials, and so on. It is amazing to see how much extra work and value come from the mere fact of the existence of this examination.

The whole question of examinations is one on which one's views change greatly as the years go by. There is a real value in imposing discipline on students in this sort of way. The nature of the examination may be different and the examination itself may be bad, but the discipline of having to sit for it is of great value to the students, in forcing them to do some work.

One thing which irritates me about student life in the university is that the students are very poor indeed in providing for themselves an antidote to specialisation. The student societies in many universities are limited to the subjects in which they are specialising. There is a mathematics society, a physics society, a chemistry society, and so on, and there is no worthwhile contact between them. Why at least do they not have a science club or something of that sort, which is more general? However, they will not do it, and it is difficult to arrange it for them, because one does not want to interfere with societies of this kind.

So far as the tutorial question, raised by Professor Jeffery, is concerned, things ought to be easier in the large science department, which nowadays has a staff more than adequate

to cover undergraduate teaching responsibilities of the usual kind, so that it should be possible to arrange for more personal tutorial work more easily This is more difficult in smaller departments than in others, but I think that the size of the department is no excuse, and should be an opportunity

It has been pointed out that professors are apt to forget that all their students after three years are not going on to do research. There is the important point, however that nowadays the number of people accepted into research is a rather greater fraction than before. One comment on the whole question of maturity is that after three years we still cannot judge those who will prove to be best in their profession, and even those who do not mature rapidly enough to get second-class honours may come to the fore after three years. We must be more liberal than in the past on the question of admitting people to do research, allowing at the same time for the fact that we are educating them further in doing so I think that the idea of the M.Sc. is a good one, but there are difficulties of a financial kind and in regard to deferment. If we are to allow people to do a fourth year for the M.Sc. there must be adequate financial grants to enable them to carry on *and it must be possible to get deferment for them to carry on* in this way

There is no need to say anything further on the question on which Mr Wolfenden and I appear to disagree, the question of the schools and where to start the courses. I do not suggest that we should assume that they have learnt nothing at school but in a science subject, and particularly one such as physics, they have to have the principles expressed to them in the fashion which is going to be used throughout the rest of the course and it may be a different fashion from that which they have learnt at school. I feel that they should have these things expounded to them, assuming that they have some knowledge but not assuming that they have the attitude which we want them to have in following the principles of the subject. *I do not suggest that this should be done with facts* but just with principles. I do not believe that the schools will feel that this completely takes away the need for their sixth form courses. In the sixth form if they are given real freedom to study the subject, what they actually do in detail is not so very important.

The CHAIRMAN It remains for me to thank all the speakers for their share in making this session such an interesting one, and in particular to thank our two opening speakers, Mr Wolfenden and Professor Massey

THIRD SESSION

Saturday Afternoon December 18th

THE RETIRING AGE FOR UNIVERSITY TEACHERS

Chairman H. R. Robinson D.Sc., F.R.S Professor Emeritus of Physics and Vice-Chancellor University of London

The following summaries of addresses were circulated prior to the conference

A. Summary of Address by Mr H. R. F. Harrod.

1 This matter should be looked at primarily from the point of view of national need. We have to face the fact that in the next few decades Britain will have a population of growing average age. This matter has recently been brought into prominence by the Report of Sir Thomas Phillips's Committee. The growing proportion of relatively old persons will mean that an increasing proportion of the product of those of working age will have to be taken from them to support their seniors. All should play their part in giving facilities to the older people to contribute work according to their ability even if in certain cases this means inconvenience. The universities must not hold back. On the contrary containing, as they presumably do, the most highly educated part of the population, they should be the first to appreciate and adapt themselves to the new situation that confronts us.

2. Fears have been expressed that an extension of the retiring age will be an obstacle to the entry and promotion of the younger generation into the academic profession. Actually the expansion of the universities that will continue to go forward will give them a greater number of openings than they ever had before. But even apart from this, and supposing the universities to be quite stationary in the number of positions offered, the younger generation would still have greater opportunities than they have ever had before owing to the changing age composition itself. Within no distant

date the number of retirements per thousand persons reaching the age of admission to university appointments may be expected to be nearly twice as great as it was in the inter-war period. There will be no lack of opportunity for young people, and this applies also along the line of progressive advancement.

3 We come to the question of the suitability of persons for academic service during the few years after the age of sixty five While in some respects there may be a decline of capacity in others there may even be an increase In the arts subjects, mellowness of judgment and depth of understanding are the supreme qualities. The capacity for expounding subjects in a lucid and stimulating way may continue to grow with the growth of experience. In arts subjects, knowledge of the most up-to-date researches is relatively unimportant.

4 In science the matter may be somewhat different. It is possible that the older man finds it difficult to adapt his mind in a rapidly advancing subject, or to have good judgment about the most important lines of new research in relation to it. But surely the older scientists remain good for some purposes? This is a case for adapting the internal organisation A man could carry on with professorial duties even when no longer responsible for initiating research in a laboratory From this point of view even sixty-five may be too old a retiring age. Professors relieved of responsibility for a laboratory could still give valuable lectures on basic principles.

5 In both the arts and sciences more of the ever-growing burden of administration and committee work could be devolved upon the senior people At present too many men in their prime of life and ability to research are subject to the growing encroachment of administrative duties within the universities. Critics may object that this would be putting all the power resulting from membership of sundry committees into the hands of senior people. But it must always be remembered that administration and committee work are matters of secondary importance in the life of a university Provided that decisions taken do not lower academic standards and are in accord with common sense they will be good enough The time of younger people should be left free for their primary duties to the greatest possible extent.

B. Summary of Address by Professor J F Baker.

The case for raising the retiring age of university teaching officers can be considered under three heads. Would it be in the interest of (*a*) the community having regard to the

ageing character of the population, (*b*) the officers themselves, and (*c*) the university?

(*a*) If there is an argument for employing older people, the best solution may not be to use them for the same work or for the same amount of work. If a teaching officer has lost his effectiveness at 65 he should certainly give up his post; if he has not there are plenty of worthwhile activities open to him and he does not cease to be a productive member of the community

(*b*) The financial advantages which would accrue to a teaching officer from the extra years on full stipend and improved annuity on retirement must be weighed against the fact that appointments and promotions would occur later throughout his career

(*c*) There may be no evidence of any particular biological or psychological changes between the ages of 65 and 67 but there is a weight of well informed opinion that most teachers powers wane appreciably between those years the same applies, in the sciences at least, to research and the direction of research. To raise the retiring age will therefore diminish the over-all effectiveness of the university as an institution for higher education and research. To university officers the interest of the university should be paramount. The young people of today face many new problems, including those arising from the increasing age of the population. It would surely be wrong to diminish the efficiency of the very institutions whose principal function is to educate the young to face these problems.

The CHAIRMAN For this afternoon s debate we are fortunate in having two distinguished speakers taking almost diametrically opposite views, one an economist and one an engineer We have a Chairman who retired before the existing normal age and who is therefore disinterested, while the two opening speakers are both sufficiently far removed from any retiring age which has been named to take a perfectly objective view I can do no better now than to call on the first of the two opening speakers, Mr Harrod.

H. R. F HARROD M.A., F.B.A., Student and Tutor Christ Church and Nuffield Reader in International Economics, University of Oxford I come to my opening remarks quite unashamedly in presenting this problem to you as one of national interest. We are now an ageing population. This process has been going on for some time. We have a pattern

which is quite different from that to which our various institutions and customs were adapted in the nineteenth century The figures which I am going to give are probably quite familiar to you, but I shall repeat them. At the turn of the century in 1901 only 47 per thousand of the people were over 65 By 1921 it was 60 per thousand, and by 1947 it was 104 per thousand. Then it began to rise more steeply In 1952 it was 112 per thousand in 1962 it will be 125 per thousand, and in 1972 it will be 150 per thousand.

This great change presents a major problem to our domestic economy It is probably the most important domestic problem before us. It means that the working population has to sustain a larger number of old people, and a very greatly larger number· and that means, if you look at it in a broad way that an ever-growing fraction of what they produce, their products and services, has to be set aside to sustain the old people That means that, especially in the two decades ahead, the fruits of progress, instead of going entirely to raising the condition of the people, will be severely drawn upon to sustain old people, which will have the effect of diminishing incentive and hope amongst those who work for themselves, because as they work harder and more efficiently and produce more this is siphoned away from them.

The natural thing to do therefore is to consider whether the old people cannot themselves contribute something to ease the burden, where they are still able and willing. I would say at the outset that I do not think that anyone here contemplates even an indirect element of compulsion. The idea of extending the retiring age will be on a purely voluntary basis, in the sense that a man will be entitled to retire at the pre-existing age with whatever pension expectations he may have and no moral or financial pressure will be brought to bear on him If he is willing to continue, the question will be reduced to one of ability to which I shall come in a few minutes

This is a very grave and fundamental national problem, however and I do not think that the universities can stand aside and say that they are going to consult only their own efficiency and convenience. I do not think that this proposal for raising the retiring age will involve loss of efficiency but, even if it did, in such a very grave national problem as this there is a moral obligation involved. If war breaks out the universities do not say "We are more important, and must do what suits ourselves." On the contrary the universities contribute, like everybody else, to the war effort. In this great internal problem which is before us today it is for the universities, which presumably represent the most highly educated part of the population, and can therefore well under

stand how serious the problem is, and understand it well in advance of others, to show their appreciation of it by doing something about it.

That is my little moral exordium. Whatever the convenience of the universities may suggest, it is a question of plain moral duty for them to make their contribution, along with other professions and trades. This extension of the retiring age will become very widespread, and they must make their contribution even at the cost of inconvenience.

The argument has been put forward that it is hard on the younger generation, and that is the next point with which I wish to deal. If the old fogeys continue for longer than was expected, it is said, the younger people will be held back and will not get professorships and so forth. We cannot deny that an extension of the retiring age will in itself diminish the number of vacancies which would otherwise occur but it would be quite wrong to suppose that this move will mean that the prospect for younger people is going to be worse than that to which they have been accustomed and have had in the past. On the contrary the prospect for the younger people is going to be very much better. There is the obvious point that the universities are themselves expanding rapidly their staffs are expanding, so that the number of academic jobs per thousand of the population is rapidly increasing. Some people have asked whether it is possible to expand at the pace required without losing something of quality in the body of teachers. It is to be hoped that that can be done, but it is not possible to brush that aside as being a problem which does not exist. This expansion itself, therefore gives the young an opportunity of finding appointments which they would otherwise lack.

Apart from all that, and even supposing that there was no expansion in the universities, and that the number of positions in the universities was destined to remain quite stationary for the next two or three decades, nevertheless the young would have an unprecedented opportunity owing to the change in the age composition of the population itself. At this point I must give you some statistics. I am going to give you only one row of figures, because I am sure that a plethora of statistics would be unwelcome. I have gone into this matter carefully and taken some trouble over it, because in view of the distinguished character of this audience I thought that it was due to them that I should do so. In getting this column of figures I have based myself on the Royal Commission on Population. Although there is a little more recent information obtainable I thought it best to do that, because the Royal Commission went into this question much more thoroughly than anyone else has done, and because they take an impar

tial, objective view and also because in this very tricky question of vital statistics it is essential to derive one's figures from one source only and not to have more than one.

The only thing of importance that has happened since the Royal Commission reported in fact helps my argument, and that is the renewed fall in births. At the time that the Royal Commission reported, we were still on the later part of the high level of births which started during the war and went on for four or five years after the war. Since then the births have dropped, not quite to the pre-war level, but to a level not far above it, and they have been running like that for the last three or four years. Where there is a doubt about the future population in the mind of the Royal Commission therefore, we should look on the pessimistic side which is, of course, the side favourable to my argument.

There is one further point which I should like to mention. I am going to give you these projected figures for the future. The Royal Commission went very thoroughly into this and worked out projections on the basis of 16 alternative possibilities. I have looked at all these 16 and taken combinations out of all of them. I have scrutinised the figures and taken the figure which is most favourable and the figure which is least favourable to my argument. I take the age group from 60 to 64 as showing impending retirals during the next five years, and the age group from 20 to 24 as showing impending arrivals, the candidates or aspirants. I confess that I have taken those five-year periods because the statisticians happen to work with them, but I think that the periods in question are the most suitable for our purpose. 20-24 may be taken as the people looking for jobs, and 60-64 as those about to retire.

I have taken the year 1931, a mid inter-war year, as 100, and I give you the ratio of impending retirals to impending arrivals, so that the higher the number is, the more favourable it is to the younger people. I call this the index of opportunity for the young. This index of opportunity runs like this: looking backward from 1931, for which it is 100, we find that in 1921 it was 84.5 and in 1901 it was 60; looking forward from 1931, in 1941 it was 129, in 1948 it was 139, for 1952 I give two figures, the most and the least favourable, 155-150, for 1962, 193-181, for 1972, 186-171. The figure for 1972 comes out slightly lower owing to the great increase in births during the war and the immediate post-war period. The children born at that time will be grown up in 1972.

The essence of my argument is that so far as opportunity for the young is concerned, even if the universities remain quite stationary, that opportunity is going to go up in the proportion which I have mentioned, merely owing to the age

composition of the population I shall give those figures in tabular form, because they seem to be the crux of this problem

1901	60
1921	84.5
1931	100
1941	129
1948	139
1952	152.5 (mean figure)
1962	187 " "
1972	178.5 " "

In other words, the young people are going to have three times the opportunity that they had at the opening of the century and nearly twice the opportunity that they had in the inter war years. In the light of those figures, I pray that we may hear no more of this cry-baby talk of the poor young people who are being kept out of their legitimate aspirations by the wicked old fogeys going on for two or three years longer

I must say something about the question of the suitability of people of 65 or whatever it may be. It could be said, of course that despite the national need, and despite the opportunity for the young about which I have been talking, if people at the age of, say 65 are manifestly inefficient, that would override my case The suitability of these people is, of course, a complex question, but I would submit that although in some respects their efficiency may be declining —we need not deny that—in other respects it is not declining, and *in some respects it may even be said to be increasing.*

I think that here we must draw a very big distinction between the arts subjects and the sciences. In the arts subjects the great qualities required are mellowness of judgment and depth of understanding. In the arts subjects it does not matter if a professor of 65 is rather weary of reading the latest periodicals and keeping up to date. The object of the arts education is to give people understanding, and we all know men of great judgment and wisdom who retire and we regret that the next generation of students will not have the opportunity to make contact with their minds. Very often the power of clear speech and apt phrase, and even the power of stimulating speech, is not on the down-grade at the age of 65 We look at other professions such as politics and the law and we find that the power of expression is not one which seems to decline at that time of life.

Another point which must be borne in mind is that we are not comparing the powers of men of 66 or 67 with their *powers in their very prime of life. I shall not venture to say* whether the prime of life is 40 or 50 but we must not com

pare them with the time when their powers were at the peak, but with what their powers were at the age of 25 There may be many young people in the 20s who are doing vital research and who are full of stimulating ideas, but it is not my impression that people in the 20s are at the top of their lecturing form by any means. I do not think that the youngest batch are the best lecturers. You have to compare these older people of 60 to 67 years of age with the people who will replace them at the age of 24 or 25 and it is very doubtful whether the older lecturers are inferior indeed, I would say that although it may be the case that in certain respects there is a decline there are other important respects, certainly on the arts side in which the powers are not declining and may even still be rising.

In the case of science it has been put to me strongly and I appreciate the point, that it may often be very difficult for a professor of 65 to tumble to the real inwardness of the latest things which come along in science, and he may not, therefore, be the ideal person to direct research projects. He may insist on going on flogging dead horses, and may not realise what, from the point of view of a rapidly-developing subject, are the vital ways in which research can proceed. I feel that there may be some truth in that, but surely this is a matter for internal adjustment? There is so much to be done in a university We should be able to say that for jobs carrying responsibilty for new research projects there should be a certain retiring age and 65 or even 60 may be too old for that work. We must be prepared, however to put our selves to a little inconvenience to assist with a national problem, and with a little trouble we can arrange that the responsibility for initiating research and directing a laboratory shall come to an end at a certain age but the scientist can go on giving lectures on basic principles and conducting seminars there is so much to do in a university that there should be enough to give him employment until a later age. That objection with regard to scientists, therefore, can be met by an internal adjustment and should not affect what we do on the broad issue

I should like to say a few words about administration and committee work in universities. I must speak very tactfully here, because clearly this audience is somewhat biased on the side of an interest in the various administrative problems of universities. I am sure, however that everyone here will feel that there is too much committee work coming on to the younger people A man engaged on important research who is doing his essential life-work in his 20s and 30s should be as far as possible kept off committee work He has to have a load of teaching and examining, and if you put committee

work on top of that you may frustrate the real work which is the true object of the university namely his research.

I should like to speak personally for a moment, and I hope that it will not be regarded as in bad taste. I myself in the 30s was encouraged to do a great deal of committee work in Oxford. People came along and said, "We want young men to go on to this and that body" In my 30s I spent a very high proportion of my time on administration and committee work. I deeply regret that. It was a mistake on my part to have yielded to flattering advances and allowed myself to get involved to that extent, because if one lets the time slip by one will miss opportunities for really creative work which ought to be one's main preoccupation at that age. I would therefore say that the ideal would be that no one should go on to any committee at all under the age of 40 There is quite enough to do in other ways.

Some people may say "That is monstrous. You are suggesting that all the power should be put into the hands of the old people." I do not attach very much importance to this question of power If a young man is so keen that the old people shall not have the power he has missed his true vocation, let him go into politics or government, where power matters. Power should not be important in the universities. There are two things that are necessary that academic standards should be maintained and that common sense should be applied. That is what we expect from the decisions of committees, and it would be wrong to deny that people of over 40 are capable of maintaining these two things. If, therefore you are in any doubt about the full employment of the older people, I would say that there is this vast and growing and indeed oppressive mass of administrative work to be done in the universities, and they can take a fuller share in all that work.

I have now exceeded my time, but I should like to recapitulate. I say that even if it was inconvenient to us, from a national point of view there is a moral obligation on the part of the universities to do something to meet this great national difficulty which has come to us. The younger people are going to get far more opportunities of advancement than ever before owing to the changing age composition of the population. There are enough respects in which people are thoroughly useful and efficient at the age of 65 to justify our continuing to make use of them for a further period.

The CHAIRMAN We must all be most grateful to Mr Harrod for the clear and incisive way in which he has put the case for extending the age of university service. I now

have pleasure in calling on Professor Baker to do his best to destroy that case

Professor J F BAKER, O.B.E., M.A Sc.D D.Sc., Fellow Clare College, and Professor of Mechanical Sciences, University of Cambridge I have never liked admitting that I am at a disadvantage, but I confess that I feel so now As the Chairman said in his introductory remarks, this question of the retiring age is somewhat personal, and it is impossible to adopt an entirely objective approach. Mr Harrod has given us impressive statistics, but I do not believe that there are any really firm data on the efficiency of teaching officers. He I feel, was in a somewhat happier position, because he was able to take a kindlier view of the activities, or some of the activities, of university teaching officers and even of administrators. He could have quoted cases and have named men of distinction who have continued to give able service after the age of 65 They are exceptional, but it is clearly not so easy for me particularly at this Christmas season, to retort so personally I must content myself with generalities, and largely with the fruits of my own experience.

I do not think however that there is very much separating Mr Harrod from me In his summary he urges that "All should play their part in giving facilities to the older people to contribute work according to their ability"—and those are the key words, "according to their ability"—"even if in certain cases this means inconvenience." I believe that those are key words, too

Turning to the summary of my own address, I say there that the case for raising the retiring age of university teaching officers can be considered under three heads. Would it be in the interest of (a) the community (b) the officers themselves, and (c) the university?

With regard to (a), if there is an argument for employing older people the best solution may not be to use them for the same work or for the same amount of work. There is no argument between us about the need and advisability of giving people the opportunity to work longer If each case could be measured on its merits there would be no trouble, and where a university has the courage and the machinery to consider and decide each case there seems to be no problem If a man is able to carry out his university duties at the age of 65 he could be kept on but if he cannot carry them out, clearly he should relinquish his post.

This does not mean, however that he cannot make further contributions to the nation's effort. There are few of us who cannot do something useful as we grow older The process starts long before 65 A man may reduce the effort which

he puts into research, and tend to teach more. Later he may reduce the time he spends on the arduous work of college teaching, and turn more to committee work. The crux of the question is how far and for how long these processes can be allowed to go on in the somewhat complicated organisation of a university

I believe that Mr Harrod sees them going a long way he says, "even if in certain cases this means inconvenience." This is where I begin to disagree. The decision must be made on the basis of productivity if you will forgive my using that word in connection with academic work, it should not be made on the humanitarian ground of keeping the old men happily employed in their other work. Surely as we are the most highly-educated part of the population we can be trusted to spend our declining years happily enough, if the economic conditions are satisfactory

That brings me to my second heading, the economic argument. This, I feel, weighed most heavily when Cambridge decided to raise the age of retirement. There are obvious advantages to the older men in working extra years on full stipend—those extra years of plenty followed by much improved annuities on retirement. There is, of course, the other side of the case, but I have not the courage to advance that this afternoon, after what Mr Harrod said. According to him the younger men have much greater opportunities before them in the coming years. They may be no worse off but the people who will be worse off are the undergraduates.

This brings me to my third head, whether an increase in the retiring age would be in the interests of the university as a whole. This is the serious question. Our products are so important and valuable that we cannot countenance the use of more blunt or rusty tools. Mr Harrod seems satisfied that while in some respects there may be a decline in capacity after 65 so far as arts subjects are concerned this does not matter Knowledge of the most up-to-date research, for instance, is relatively unimportant. I am prepared to take his word for this so far as the arts are concerned, at least for the moment, but he goes on to say that in science the matter may be somewhat different. Well, I can assure you that in science the matter is most certainly different.

Whether it is that we scientists are weaker or have to work harder at our subject, with its boundaries ever widening and making greater demands on us whatever it may be, I am convinced that it is rare to find a scientist in university work whose powers are not waning considerably before he reaches the age of 65 He may be capable of doing many more years of valuable work after that age if he narrows his field, but such are the demands on most of us today that, remembering

the whole range of teaching, research and administration it would be better for the teaching of the undergraduates we teach, for the research workers we should inspire, and generally for the departments which some of us look after if we went at 65 It would be better still in many cases if we could be persuaded to go earlier This is, of course, my own impression from observation of science departments in several universities, and particularly from ten years or more of intimate contact with a large and unusually able staff in one department.

With very few exceptions, the tired man on retirement, when relieved of his university duties, continues to work, and to work most efficiently as a full-time research worker or as a college teacher The country is not deprived of his services. In fact, compulsory retirement at 65 means that he is replaced by another more able to carry the heavy burden which university work represents today and is himself freed at an age when it is still possible to become efficient again in a narrower field.

My observations have covered professors, readers and lecturers. The worst danger comes, however from the head of a scientific department. Whatever quarter the universities may give to others, the head of a department should be allowed none Of all the run-down university departments which I have seen I can remember none which got into that state due to too much handling by young men always the trouble could be traced to a head being retained too long

I have no doubt myself about scientists. I am not prepared to be so dogmatic where humanists are concerned, but not all of them agree with Mr Harrod's view Let me quote what one of them has said. This is from Sir Ernest Barker's book *Age and Youth*. Nobody could suggest that Sir Ernest Barker showed premature signs of failing energy Dealing with his retirement in the autumn of 1939 he says "Retirement thus coincided for me with the beginning of a period of six years of war and just for that very reason my retirement was only partial and I found myself engaged in activities of various sorts and kinds during the whole of that period. War summons all men to work, even retired professors, and within a month of retirement I found myself invited by the Vice-Chancellor of Cambridge to act as university director of studies for some courses of instruction which were being planned by the War Office for the benefit of selected officers." He goes on at some length to describe the courses which he gave, and he says "One other thing which I learnt not only from the fourth course, though I noticed it particularly from that course, but also from the other three, was that I

had now fallen away from, or at any rate lost my old touch with the mind of the undergraduate student. I imagine that this was a matter of age and, if I am right in that case I see another reason for the retirement of a university teacher when he reaches his middle sixties. He ceases to feel satisfaction in contact with young minds, and, what is more serious still, he ceases to be able to give them satisfaction. At any rate that was my experience. The undergraduate, I felt, was still as able as ever: he loved to play with ideas, but he was apt, after all, to play."

I must say that I quite seriously believe there is a weight of well-informed opinion that most teachers' powers and interests do wane appreciably, though they may not realise this themselves, before the age of 65. To raise the retiring age generally will therefore diminish the over-all effectiveness of the universities at a most critical stage in our history. Our personal economic difficulties should not sway us. University teachers as a class have never put their financial needs before the good of the institution which they serve. Retirement from a university post need not mean the loss of a man's efficient service to the community. The kindest transition can be brought about by retaining the man in the university circle but reducing his position and duties, as Mr. Harrod has suggested. I am *not* prepared to go all the way with him, however: I would not leave retired men in charge of administration. Let them do executive work by all means, and if they can find a way of relieving us of the weight of committee work, so much the better; but I am not very happy about that. I do not want to see the active man blanketed with an even denser layer of professional committee men than exists today.

Cambridge decided by a very small majority that it must be all or nothing, and that no use could be made of a retired teaching officer. I cannot understand the difficulty, but there it is, and so many of us in Cambridge will struggle on far beyond our prime until we are 67. We could, of course, retire at 65 or earlier, but will we? I believe that the most miserable years of my life, if I survive so long, will be between the years 1966 and 1968, when my arteries will have hardened to such an extent that I shall not be able to let go, in spite of all I have said in 1954. I urge teachers in other universities to guard themselves from my dilemma.

The CHAIRMAN: Thank you very much for an extremely frank, personal and pointed statement. The subject is now open for discussion.

The Rt. Hon. Lord Chorley of Kendal (*Association of University Teachers*) Professor Baker hit the nail on the head when he said that we have not the proper data to allow us to come to a satisfactory decision on this difficult question My plea would be to the psychologists in particular to devote a good deal of time over the next few years to trying to work out some objective method of discovering whether at 60 65 67 or whatever the age may be people do really begin to fall off in mental work in a marked way I think that Mr Harrod's method of taking the population as a whole and praying in aid the Phillips report, and so on, is beside the question The fact that people are now physically better and living to much older ages is really utterly irrelevant to the question of their mental ability and capacity to do the work of university teachers. I think it is essential to have over the next few years some data which will enable us to form a really objective judgment on this matter We are all getting to a stage when we are so personally interested in it one way or the other that we are not able to form such a judgment.

I feel that a good deal of Mr Harrod's argument was rather specious. The age of 60 or 65 must have been *fixed* no doubt a long time ago, because general experience seemed to point to that sort of age as being the age at which people's mental quality and ability to use that mental quality in the teaching of students, began to fall off in such a way that they ought to retire It may well be that that happens to some people at 60, but it is certainly not general. In the council of the Association of University Teachers and in our committee meetings we have found, rather to our surprise, that in a number of university institutions there is still in existence a compulsory retiring age of 60 at which men and women are in fact in the present year being compulsorily retired. I suggest that it is clear that the consensus is that people are good enough up to the age of 65 and should not be compulsorily retired at 60 We might all agree that the age limit of 60 should be removed.

While we shall all agree with Mr Harrod that this matter must be settled in the national interest, I always suspect an argument which starts with that sort of opening gambit, and when he goes on to say that in the universities we perhaps tend to consult our own efficiency rather than the national interest I begin to wonder where his argument is leading him. It is surely an outstanding national interest that the universities should be as efficient as possible and the best thing that the universities can do in the national interest is to preserve their own efficiency If efficiency is required anywhere in the whole range of national interest it is surely

in the universities, where the minds of the leaders of the nation are being formed and where the habits of work and the whole culture of the nation are at stake. I do suggest, therefore, that this matter must be looked at from the point of view of what is in the interests of the efficiency of the universities.

I feel also that Mr Harrod's argument about the opportunities for the young was unsound. It is not a question of whether there are more university jobs for the young entrants to go into when starting their career but of what the effect is on young men after they have become university teachers. To that matter it does not seem to me that the statistics which Mr Harrod quoted are relevant at all.

Mr HARROD The statistics would be very similar if instead of taking the age group 20-24 we took the age group 40-44 when presumably people are looking for chairs. The same increase of opportunity is manifest.

LORD CHORLEY I should have thought it stood to reason that their promotions were in fact being deferred for two years at a time which is very critical for them from almost every point of view I do not say that we have not to put up with that, but it does adversely affect the younger man that he should have to wait for that additional time before becoming head of a department or getting a chair with all the opportunity which that opens up to him, and when from the purely economic point of view in regard to the education of his children and so on, he needs the increment. It seems to me that those are very relevant factors indeed from the point of view of the efficiency of university work.

I come back to the fact that it is the efficiency and effectiveness of university work which is the prime consideration in this matter It seems to me that sufficient data have not been provided to enable us to say that the age limit can be extended to 67 without there being grave danger of irreparable harm being done to work in the universities.

Dr C. B. CHILDS (*Edinburgh*) There seems to be much doubt in many persons minds about the effect of raising the maximum retiring age to 67 Lord Chorley remarked that we have no data to work upon. Professor Baker said that we have no firm data on the efficiency of teaching officers and referred to "rusty tools" I would ask him whether he seriously suggests that the efficiency of the Scottish universities is markedly inferior to that of the English universities, or has been so over the last fifty years? And I submit that we already *have* the relevant data.

Appointments to Scottish chairs used to be *ad vitam* when F.S.S.U was introduced a maximum retiring age for professors was fixed in three Scottish universities this is 70, in the fourth, 65 with provision for extension by annual invitation up to 70 (My data exclude clinical and special cases.)

At Aberdeen *all* members of the teaching staff normally serve until 70 At St. Andrews and Edinburgh professors retire at 70, non professorial staff at 65 with provision for readers to continue by annual invitation up to 70. At Glasgow the normal retiring age is 65 with possible extension to 70 for professors.

Despite this I am sure that we cannot seriously impugn the efficiency of the majority of university departments in Scotland and, if we can quote the odd case of impaired efficiency I think that we can find precisely parallel cases in England and Wales despite their lower retiring age of 65

It has been said that to raise the retiring age would markedly affect promotion. I have 32 years experience in Scotland of university teaching and participation in staff affairs and have also opinions from teachers antedating my period of service. So far as I can ascertain, no complaints have ever been voiced by younger members of the staff of promotion being blocked because of the higher maximum retiring ages widely prevailing in Scotland

I suggest therefore that we have very definite data which confute statements that an increase in normal maximum retiring age above 65 must impair efficiency and opportunities for promotion I am quite in accord with Mr Harrod I feel that the time has come to review the position and that the maximum retiring age should be raised at least to 67

Dr W M Shepherd (*Bristol*) We have heard a lot about this problem from the point of view of the national interest, the interest of the universities, and the interest of members of the profession up to the time that they retire, but we have not heard much about their interests after they retire. We belong, we hope, to the class of people who are going to be useful throughout their lives, or very nearly so It seems to me that the problem is this at what age is it most efficient in the general interest that we should change our form of usefulness?

Retirement is a very important step in a man s life, and to cope with it successfully requires a certain amount of adaptability Is it not better that this change should be made before this adaptability wanes? I think that adaptability is the characteristic which is most likely to wane Is it not better to make the change at 65 or so, when a man has sufficient

adaptability to assume the occupations and habits most likely to lead to a happy and useful old age?

Professor A. J. Brown (*Leeds*) Since Mr Harrod and I may be—I am not sure—the only two economists in this room, I feel that it is up to us to maintain the reputation of the profession by disagreeing. I am powerfully strengthened in my determination to do so by the fact that I do indeed disagree with him.

One point which seems to me to be of immense importance is in effect a quantitative one. Mr Harrod rightly tells us that the proportion of people over 65 in the population has increased from 5 per cent. to 10 per cent., and will go on increasing, so far as we can foresee, to 15 per cent. It is, of course, also true, though it may be irrelevant so far as the future is concerned, that this increase has been very much more than offset by the decrease in the number of people under 15 so that the proportion of people in the active age groups has increased from 60 per cent. fifty or sixty years ago to 70 per cent. today

So far as the future is concerned, when we look, as he has done, at the report of the Royal Commission on Population, we see that, taking the most pessimistic (in this respect) estimates, there may be a falling back of the active proportion of the population by about 5 per cent within the next 50 years, that is to say about half-way back to where it was in Victorian times.

What does that mean? It means, I suppose, in itself and by itself that the output per head of the whole population will fall by something like 8 per cent. (or let us say between 5 and 10 per cent. to give a margin for error) over a period of 50 years. That, of course, is not really very much I do not myself see this as a national crisis when viewed against the background of a steady increase of productivity which may I suppose, be anything between 1 and 3 per cent. per annum it has been at least 1 per cent. in the past, and it will be 3 per cent. if we manage to equal the rate of progress in the U.S.A.

It seems to me that what matters much more than this fall of 5 or 10 per cent. in 50 years is whether the rise in output per head is 1 or 3 per cent. per annum in the next 50 years and—let us make no mistake about it—that depends on the efficiency of the universities to an extent which is going to become ever greater As we move forward into a scientific and technological age, this becomes more and more important. Mr Harrod made some concessions to this point in his remarks about the science side. Perhaps it is because the university from which I come is largely a scientific and tech

nological one that we turned down by a very large majority a proposal to raise the retiring age when we debated it in the senate last year

I cannot myself speak for the natural sciences, but I find great evidence in my own subject that a raising of the retirement age might have a quite appreciable effect on the efficiency of the universities. There has, of course been a very great change in economics in the last twenty to thirty years, in which Mr Harrod himself has played an extremely distinguished part. I wonder whether he has had the same experience that I have had in being amazed and shocked at the slowness with which that change has penetrated into schools of economics in a good many universities? I do not know how important the efficiency of economists is to the national economy but I am sure that the efficiency of a great many people on the science and technological side is of great importance to it, and, in view of the orders of magnitude of the quantities involved, it seems to me likely that a raising of the retiring age in the universities will damage output per head in this country rather than benefit it.

Mr A. YOUNG (*Association of University Teachers*) The prospect which faces me is rather more drastic than it is for most of you because I am faced with the problem of retiring in the year 1984 It seems to me that something has to be done about this, and therefore I feel that I have to support the case put by Mr Harrod However having come to the university profession after rebelling from the actuarial profession, I feel that we must keep statistics out of this. I must confess, after my actuarial training, that I regard the indices quoted by Mr Harrod as useless for his purpose. He has not really compared comparable things.

I should like to say that the retiring age of 65 is fixed because we are in a strait jacket of the actuarial valuation of pensions, and for that purpose it is necessary to have some mystic retiring age. I do not know why it was fixed at 65 and there is no reason on earth why it should not have been 63 or 67 I do not know that any physiologist can say that a man of 63 is necessarily better physiologically than a man of 67 he has to judge individuals on their individual physiological state at any particular age.

The point made by Professor Baker about departments being ruined by heads being retained too long, is perfectly correct, but I know departments which have been ruined by heads who were considerably under the age of 65 and who should have been retired years before. The system seems to me to be quite wrong. It is based on a statistical concept applied to individuals, whereas to individuals one must apply indi-

vidual concepts, and a man should be judged for retirement according to his ability I know that the two teachers who inspired me most are both due for compulsory retirement, one next year and one the, though both of them are in the full flood of their research energies, publishing papers of internationally recognised value They will be compulsorily retired whereas other professors and lecturers who have not published anything for years past will continue to hibernate until they reach the age of 65

I would say therefore, that one ought to judge these things on the basis of whether the man is worth retaining, and on that alone, not on the statistical concept of "He is now 65 get rid of him."

Mr Harrod Mr Young said that my figures were not comparable, but did not vouchsafe any explanation Could he say anything further on that?

Mr Young If you take the total population of people born in 1935-39 and compare them with the total population born in 1885-89 you are comparing two different groups of people. You will not get an index of populations of university people Before the war 0 7 per cent. of all children became university students, and now the figure is 1 7 This must affect the index so that one must consider what proportion of the population one should include in the calculation of the index at different times. It is no use including in statistics of university population all the labourers of the country because they have nothing to do with the universities. One must get what the actuary would call a homogeneous population It is no use taking the whole population as one's sample

Professor R. E. Peierls (*Birmingham*) I apologise for speaking a third time in this conference. The point which I want to make is in line with what Mr Young has just said It seems to me that the discussion so far has been over concerned with averages, when everyone who is concerned with teaching statistics knows that students must be warned against the mistake of viewing everything that happens against the average. I reinforce that to them by telling the story of the family with four children who did not want another because they had read that every fifth child born was Chinese.

I am sure that we all know that the difference between the ability and the faculties of any one professor or lecturer at the ages of 65 and 67 is far less than the difference between any two members of the university staff at the same age and

therefore it is clear that whether the retiring age is 65 or 67 or any other age it will mean the retirement of a number of people who would still be very useful, and more useful than their successors, while a large number of people will also stay on whom it would be better to replace by younger men. When we are comparing the two cases, therefore, we should compare not what is the difference between the two ages, which is quite irrelevant, but rather how we want to compromise between the numbers of people of either kind

I would therefore plead, as Mr Young has done, for flexibility Keep the retiring age at 65 if you like but make it possible, and indeed easy for the right man to be asked to continue It may be said that this would be very embarrassing. Some people in the university would have to discuss the merits of their colleagues or staff. The university is not run however for the convenience and peace of mind of its administrators. We have to face awkward decisions. We have to do so when we appoint a new professor or member of the staff That is also very difficult and embarrassing, particularly when, as so often happens, one of the applicants is a colleague whom we know very well and whose merits we have to compare with those of others. We do not say on these occasions, "Let us make the job easy by giving the post to the oldest man, or to the one who has published the most papers," or in accordance with any other formula which would get us out of the difficulty of making a decision I submit that the problem of dealing with retirement is the same, and should and could be handled in the same way

When we are concerned with the possible retirement of a professor—or any other member of the staff but it is probably more embarrassing in the case of a professor—let us use the machinery which is in any case needed for his replacement, an electoral board or whatever it may be. Let those people consult experts in other places and go through whatever is the normal procedure, consider the state of the department, the record of the particular person concerned, the available field outside and the existence of younger people who could make a much better contribution They should then decide whether it is right for the present member of the staff to continue or whether a new appointment should be made. It may be that we cannot rely on our electoral boards to act wisely but in that case their new appointments will be bad, so that it does not really matter what the rules are.

Mr W D Borrie (*Australian National University*) I do not apologise for speaking several times but for speaking once, as an interloper in the conference from an overseas university I have listened with a great deal of enjoyment and

advantage to what has been said but may I have the temerity to return for a moment to the vexed question of statistics? I think that Mr Harrod was wrong in discussing the retiring age on the basis of national efficiency because by and large the universities, in terms of sheer economics, are inefficient organisations, and on the basis of that argument it does not matter whether the age is 65 or 67½ or 70 I think that the essential flaw in his "index of opportunity" is that he is comparing people entering in one year of one age group, 20-24 only with those who go out at the other end at 60-64 whereas he should also take into account those who die between the ages of 24 and 60 If he did so I suggest that his figure of 60 in 1901 and 84.5 in 1921 would be very much higher and might even be over 100 because at the mortality rates of those periods a considerable number of people would have died between the ages of 24 and 60 I make that point because I think it is important when considering the opportunities for younger people

Professor A. P. THOMSON (*Birmingham*) My only excuse for intervening in this discussion is that I am qualified by being rather touched by time myself, and that I have devoted some study to the problem in past years in order to obtain information and give advice on this matter My experience may therefore be of some value.

I regard with the greatest distrust all the figures produced, because they are invariably qualified by the statement "if present trends continue and no one knows whether they will continue or not. I agree that these statistical considerations should be dismissed from the argument. There are certain facts, however which are clear and stand out and are common knowledge Ageing in the human being varies enormously from individual to individual. We have not the slightest knowledge at the present time of whether that variation is due to genetic influence, though it is probable that that plays a large part, and it is certain that there are factors in the environment which modify the expression of the genes. Both factors have been established experimentally in some of the lower forms of life and possibly influence human beings. The fact remains, as was pointed out earlier in the discussion, that there are people of 65 who are vastly more efficient in every way than some others who are fifteen years their junior Those are the facts which we have to face

It was suggested somewhat glibly that ageing is inevitable. I am interested in Sir Ernest Barker's story because that is an example of how the fortuitous in a man's life may affect his whole career One of the problems which confront the

physician is whether the ageing of the individual human being is of itself inevitable or whether it is at any rate partly con ditioned by the customary acceptance of a lower standard.

There are many people like Sir Ernest Barker who were retired, and then were confronted with the war The need to meet a new situation may have helped them to maintain that astonishing youth which is the admiration of us all, because they at once found something else to do and had not time to contemplate their age. If you want a broader illustration of that, those of you who are old enough will be able to recall the position of women in this country sixty or even forty years ago, when it was the accepted view that it was almost indecent for women of good rank in society to be active in any way after the age of 45 Contrast that with the position today! There has been no physiological change, but merely a change in the conventionally accepted standard. I agree that the retiring age has been fixed by the actuaries, they were the people who inflicted it on us, and that is why it has been commonly accepted, for the con venient practice of insurance.

I want to face, however one serious practical difficulty in administration. I agree that the man who stays beyond his time affects the efficiency of the university or of any other organisation, but I am quite prepared to say after long experience, that I am sure that the efficiency of both univer sities and other organisations has suffered because men have retired at 65 when they were well able to go on, and satis factory substitutes could not be found.

What can be done? Professor Peierls, with a delightful innocence of human nature as it really is, has suggested that this serious matter of retirement should be committed to electoral boards, and he drew an analogy between deciding whether a colleague should retire and selecting a new candi-date for a chair To speak bluntly there is no analogy at all, because when it is a question of a man retiring you are inviting to sit in judgment those who are that man s colleagues, who have known him perhaps for 20 years, and that is an infinitely more difficult matter than the selection of somebody from a number of people not one of whom may be known to those who make the selection. It is this sentimental and quite proper human attachment of a staff to its older members (unless they happen to be particularly disagreeable) which creates the major difficulty

I was confronted with this problem by a very large indus trial concern that brought it to me and I will tell you the solution that we worked out. I have applied it in other directions and I think there is something to be said for it. Let us admit that the selection ultimately has to be by the

man's colleagues. How are we to get them to judge dispassionately and not to be swayed by mere affection and recommend an extension in every case? I advised the people who came to me about it that they should make up their minds roughly what proportion they would have liked to keep over the years, of the men doing the type of work in question. In their case it lay between 10 and 15 per cent., and I suggested that they should issue a directive that any extension of the retirement age should be settled by the man's colleagues, with the certain knowledge that not more than 10 per cent. of the whole of the people employed would be retained.

Everybody in a university is interested in its efficiency and, if you apply a figure like that and you know the retiring field that is coming on, you are much more likely to get a serious dispassionate judgment and the proper refusal of the man who is aged and ineffective, because you know that very soon there will be another man whom you all want to retain. With a block figure of that kind, which was applied satisfactorily in an industry of a particular type, there must be some flexibility. In universities there might well be a variation between the faculties, and in arts you might have a larger proportion. I personally deplore the decision of the older universities to make a general extension to 67. We ought to recognise that human biology is of some importance even in the older universities, and they should have exercised some discretion. My endeavour has been to suggest that there are practical means of extending the working years of certain individuals, and if it is done on a relatively small scale it can be regarded as an experimental venture. In the scientific universities there is still some regard for the experimental method.

What did terrify me was the suggestion that next year when I retire I might be committed to a psychologist. I said what I thought of the economists and their figures, but, believe me, in these matters the psychologists are equally ignorant and not only that but positively more dangerous. They have some statistics, but I should have thought that this business of the intelligence quotient and all that sort of silly arithmetic had been blown sky-high by the experience in Korea.

Professor K. E. Bullen (*Sydney*). I have had experience in three antipodean universities, and that experience leads me to comment on the suggestion of several speakers that the retiring age should vary in individual cases. I have been in one university where that has been the rule and the practical effect, in my opinion, has been extremely bad. The problem arises as to who is the right man to co

tinue after 65 and to my observation it can lead to lobbying and to a striving for administrative power Although an earlier speaker has stated that administrative power should not be important among professors, my experience is that it very often is. Accordingly I think that a formula is to be preferred in determining the retiring age. Admittedly there are objections to a rigid formula, but there is the overwhelming advantage of impersonality and of leaving no wounded feelings. It may be that in the United Kingdom you can rise to higher levels of academic conduct than we can, and I put the comment forward simply as one section of experience from a very young part of the world.

On the major question of whether the retiring age should be 65 or 67 I prefer to listen.

Professor N FEATHER (*Edinburgh*) At this late stage of our discussion this afternoon I have nothing to add to what has been said on the general topic of the retiring age of university teachers, but as one or two personal references have already crept into our discussion this afternoon I thought that I should like to pay a tribute to the memory of George Frederick Charles Searle, who died last Thursday at the age of 90 Those of us who know Cambridge physics will know the disappointment with which Searle at the age of 80 or more found that his teaching days were over Only a week or two ago I had a letter from him in a very firm hand it might have been written by a man of 60 He died two weeks after his ninetieth birthday Possibly if that birthday had not been celebrated as it was he would still be looking forward to the celebration of his centenary

Mr A. R WHITE (*Hull*) My only qualification to address you on this subject is that I am probably further from 65 or 67 than anyone else in this hall The very fact that I am a representative of the younger generation probably prejudices my case here immediately because you will quickly see how lacking I am in the abilities which older men like Mr Harrod and Professor Baker have. Nevertheless, I want to say something about what I think is the young man's case against antiquity My remarks are personal I have not gathered any statistics from amongst the younger generation

One important point, I think, is that, although cases undoubtedly differ amongst people of 65 and 67 if you do allow 67 as a retiring age it will inevitably happen that 67 will be the *normal retiring age, because of the difficulty of* choosing amongst one's colleagues. Those who have experience of university senates in giving emeritus titles to professors

will probably know the difficulty there is in refusing the title to a colleague.

I think the main case against antiquity so to speak, is that there is a tendency for conservatism in administration, and conservatism in university administration is not necessarily good, any more than it is in politics. I think that, in spite of what Mr Harrod has said university administration is important. In allocating funds here and there, in giving sabbatical leave, in introducing new types of facilities for the staff, and so forth, administration is important, and, if it is in the hands of old men only it does tend, I think, to become conservative

Mr Harrod said that slowness in acquiring new ideas, which he was willing to admit might be important in science, was not important in the arts faculty A professor of economics has already told us that it is important in economics, and I should like to say that in my subject, philosophy it is tremendously important. And philosophy is generally taken as an arts subject. In the last thirty years, there has been something like a revolution in philosophy but I think it is *true to say that very few of the philosophers in these islands* of anywhere near the age of 65 have shown any sympathy with the new philosophy or indeed, any great evidence of ever having read very much of it. That might be quoted by them, of course as an indication of their wisdom, but I think that is at least debatable. In my opinion, the facts seem to show that in philosophy there is a disinclination on the part of old people to do the extra work that is necessary to keep up with the articles in periodicals, etc., and that there is as much progress in philosophy and, I hope, in other arts subjects as there is in science.

Reference has been made to the position in Scotland. I was myself an undergraduate in Dublin where there was no retiring age and when I was there somebody worked out the statistics of the board, which corresponds to the senate, with the result that the average age was found to be nearer 85 than 65 Recent revolutionary changes in that university have shown that many people thought that that was a good deal too old.

I think that another tendency (I am putting forward the things that weigh with the young people, whether they are true or not) is for older people in lecturing and in other things to pontificate instead of arguing, and this, certainly in philosophy and I think in many other subjects, is dangerous. I notice that I myself am beginning to pontificate, although I am not old.

Again, whatever the statistics may be, I think there is no dearth of able young men to enter a university career at the

bottom end of the scale, so anything about the ageing population does not affect the possibility that there may not be enough of us.

Moreover I think that, whatever the statistics show about the increased opportunities that we shall have in 1971 as compared with 1901 we should assume (I think this would be a truism of economics) that we should have a greater opportunity if the retiring age was 65 than we should have if the retiring age was 67 But I think the point about the lack of opportunity for a younger man if the retiring age was raised to 67 is not indeed, from our point of view a very strong one. It is slightly double-edged, in the sense that, though you have to wait two years longer to get your appointment, you will presumably be able to hold it two years longer Therefore I do not think this point is as important as some younger men suggest.

The only positive proposals I have to make are that the older men should be employed usefully and that there should be useful employments for them outside the holding of the professorial appointments which they already have. For instance those who are interested in research can, certainly in arts subjects, continue their research without holding a professorial appointment, and many who are interested in research do so. Also I think that those who are very good teachers might continue their teaching. There would probably have to be an arrangement for them to teach at other universities, as it would be a little awkward if they continued to teach at their own university but there could be a system of exchange for them between various universities.

Professor D M MacKinnon (*Aberdeen*) I am running the risk of pontificating and even pontificating *ad hominem* but I think that, in fairness to the subject of philosophy one remark of the last speaker should be corrected, that is, that professors of philosophy who are nearing the retiring age are indifferent to the revolution of the last thirty years. I should have thought that Professor Broad of Cambridge who recently retired was not so indifferent, and Professor Price, to whom I myself owe a great deal and who is no longer a newcomer to philosophy has made his own signal contribution to the revolution of the last thirty years.

There is one other name that I should like to mention, and that is a name which I think means something to Mr Harrod as well as to myself H. W B Joseph. Mr Joseph taught me logic after he had retired, when he was over 67 Those of you who knew that formidable man will understand me when I say that his fierceness and relentlessness had not abated at all. He was also chairman of the education com

mittee of the city of Oxford, and I remember that one morning, after he had criticised my essay for an hour and a half, he asked me where I was to be found at 12.15 by which time he would have returned from a meeting of the education committee and be ready to finish dealing with the many mistakes which I had made. Mr Joseph was deeply critical of those who in his day were the forerunners and exponents of the revolution which the last speaker mentioned, but he spent years in trying to master their arguments. Further at the very end of his life and in the actual year of his retirement he delivered in Oxford a course of lectures on modern logical ideas, which I hope may one day be published. It seems to me to be a lasting contribution to their discussion and it shows that at 65 a man, though he may have ideas of his own, is not just an old fogey who reads nothing.

Professor E. M. WRIGHT (*Aberdeen*) My university was mentioned as the one which has a uniform retiring age of 70. The only exceptions to that are the teaching staff of certain clinical departments.

We have not found that this later retiring age produces any difficulties. Our older colleagues do not, however, as Mr Harrod suggests they might, take over a substantial share of administration. Perhaps the wisdom of age convinces them that administration is a good thing to leave to others. But they continue to provide valuable teaching and their influence tends to restrain the sometimes excessive enthusiasm of younger teachers, which leads to the problem we were considering this morning. One can always rely on the older and more experienced man to see the student's point of view and to urge reasonable restraint in the scope and degree of specialisation of syllabuses. I feel strongly that older professors and lecturers contribute an element of balance and experience which is extremely valuable.

It is perhaps true, however, that anyone who can survive into his sixties the climate of the north-east coast of Scotland must have a degree of energy, vigour and robustness likely to render him fully capable of useful work until he is 70.

A point made from the floor during Dr Child's contribution was that the Scottish universities were less efficient, perhaps as a result of their later retiring age. It is not easy to measure the efficiency of a university. But I have sat through yesterday's and this morning's discussion, hearing advanced as difficult and revolutionary measures which we already carry out. So perhaps we are not noticeably less progressive because we retain a few honoured colleagues until the age of 70.

Professor J F BAKER, in replying to the discussion, said I feel there is very little I can say in reply The only difficulty I have felt was caused by Dr Childs I know what to expect from him if I say that I had forgotten Scotland, and I think my difficulty would be only slightly less if I said that I had considered Scotland and had drawn my own conclusions. But Professor Wright has provided the solution—it is the climate!

I am drawn, of course, to the suggestions made by Mr Young and Professor Peierls, and that made by Professor Thomson in his delightful contribution, that a controlled experiment should be carried out, at least by some univer sities.

As for efficiency the most comfortable attitude to adopt is that of one of my distinguished predecessors, who, after going round the laboratory a few years ago said he thought that in a university there was a great deal to be said for a bit of inefficiency

Mr H. R. F HARROD in replying to the discussion, said After the bandying about of names that we have had on the philosophical side, I cannot refrain from mentioning the late Professor Alfred North Whitehead, who was partly respon sible for the revolution in philosophy during the last thirty years, about which we have heard. He retired from the University of London at the ordinary retiring age. He then went to Harvard, which, being more enterprising, offered him a chair and he became Professor of Philosophy at Harvard, where he wrote half his books—a rather good example of continued fertility after the age of 65

There are one or two misconceptions that I should like to clear up

Professor Baker said that we must not damage efficiency that we must not face inconvenience to keep people happily employed. I am not thinking primarily of the happiness of old people when I say that we should be willing to face inconvenience I am thinking primarily of the age distribution of the population as a whole, that is to say the national question I feel that also with regard to Dr Shepherd's remarks about adaptability There is something to be said for getting a change-over at 65 and not 67 Some people would be happier trying to adapt themselves to something different at 65 whereas others would rather go on with their ordinary work until the age of 67 I think that these con siderations must not weigh much by comparison with the problem of the ageing of the population

I think that Mr Young's criticism was just. I was framing a purely abstract idea of the university as being a microcosm

of the country as a whole and growing in the same relation as the country as a whole. Actually the number of chairs that become available from time to time in the universities depends on the rate of growth of the universities themselves, and one would have to go into the whole past history of the universities and their future expansion. On the whole it seems to me that in the next two decades there will be periods of great expansion of the universities, and therefore great opportunity for the young people My exercise in statistics referred to the nation as a whole I am open to the criticism that I may have seemed to assume that the university was a microcosm of the nation as a whole and reflected its age composition as a whole

I am also subject to correction from Mr Borrie of Australia for having omitted deaths prior to 65 To reckon this would have been a laborious undertaking which, although it would slightly modify my picture, would not, I think modify the main position, certainly not since 1921 I do feel that this general statistical picture may be useful.

Lord Chorley used the word "specious" once or twice in reference to what I said, but he himself seemed to be labouring under the most profound misapprehensions with regard to the whole topic. The main cause of our national dilemma, so to speak, is not that people are living longer though that does increase the number of people above the age of 65 The main cause of the change in proportion has been the great progressive fall in the birth-rate. That is the essential cause It is, so to speak, the lack of children, a point which was brought out by Professor Brown in a somewhat different argument. It is the paucity of children which makes the opportunity for the young good there are so few of them. That is the point which people must bear in mind

Again I believe Lord Chorley really thinks that if the retiring age is raised by two years, from 65 to 67 everybody from now on will come into their jobs two years later but that is totally fallacious. It is a once-over change. If you extrapolate over the next ten or twenty years you will see that people are going to get more or fewer jobs—say chairs —at the age of 44, depending entirely on the rate of expansion of the universities in the antecedent period and the following period. The idea that everyone will be postponed for two years by this change is quite absurd. I apologise for using that strong word.

I have been spending too much time on these statistical questions, but I am subject to correction by Mr Young, and I have wanted to emphasise that I was trying to give the national statistical demographical background against which we ought to be working.

INDEX OF SPEAKERS

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Sir Walter Moberly's book, " The Crisis in the University " (*Sir Walter Moberly Professor L. J Russell*).

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